PREVALENCE OF PONTICULUS POSTICUS IN DENTAL PATIENTS USING CBCT-A RADIOLOGIC STUDY

A dissertation Submitted

in partial fulfillment of the requirements

for the degree of

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I hereby declare that this dissertation entitled **"PREVALENCE OF PONTICULUS POSTICUS IN DENTAL PATIENTS USING CBCT – A RADIOLOGIC STUDY"** is a bonafide and genuine research work carried out by me under the guidance of DR.CH.UMA REDDY M.D.S., PROFESSOR AND HEAD OF THE DEPARTMENT OF ORAL MEDICINE AND RADIOLOGY, BEST DENTAL SCIENCE COLLEGE, MADURAI.

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"No one who achieves success does so without acknowledging the help of Others. The Wise and Confident acknowledge this help with gratitude."

- Alfred North Whitehead

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And

MRS.DR.CH.UMA REDDY aged 40 years, working as Professor and Head of the Department at the college. ,having residence address at No 9 staff quarters, ultra's Best Dental Science College,Madurai-625104.Here in after referred to as the Principal Investigator

And

DR.G.SATHEES CHANDRA MOULI aged 37yrs, studying as postgraduate student in the Department of Oral Medicine and Radiology in Best dental science college. Herein after referred to as the PG/Research student and co-investigator.

Where as PG/Research student as part of his curriculum undertakes to research "Prevalence of Ponticulus Posticus in dental patients using CBCT –A Radiologic study "for which purpose PG/Principal Investigator shall act as Principal Investigator and the college shall provide requisite infrastructure based on availability and also provide facility to the PG/Research student as to the extent possible as a Co-investigator.

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ABSTRACT

Aim

To evaluate the prevalence of Ponticulus posticus in dental patients using CBCT.

Materials And Methods

In a series of 116 patients including 66 males and 50 females aged between 11to80 yrs attending the Department of Oral Medicine and Radiology were advised CBCT for various reasons such as orthodontic treatment, implants, patients with chronic neck and head pain and TMJ disorders. Detailed examination of the patient including cervicogenic pain was recorded. Intensity of pain was assessed using Visual Analog scale. Unpaired Students't' test was used to test the significance of association between incidence of Ponticulus Posticus and quantitative variables and Yate's or Fisher's chi square test for qualitative variables. A 'p' value less than 0.05 was taken to denote significant difference.

Results

CBCT examination revealed 15 patients positive for PP giving a result of 12.9% as prevalence of PP. the prevalence of PP was more common in the age group of 11 to 20 years (33.3%) and the next common age group was 21 to 30 years (22.2%).

Conclusion

This study suggests the prevalence of PP is higher than previously believed and PP is a common anomaly. CBCT is an important tool for diagnosis and characterisation of PP in three dimensional views, providing professionals with access to excellent image quality and greater diagnostic accessory and sensitivity.

Key words

Ponticulus posticus, CBCT, Cervicogenic pain

LIST OF ABBREVIATIONS

S.NO	ACRONYM	ABBREVIATION
1	PONTICULUS POSTICUS	PP
2	CONE BEAM COMPUTED TOMOGRAPHY	CBCT
3	CONE BEAM VOLUMETRIC TOMOGRAPHY	CBVT
4	COMPUTED TOMOGRAPHY	CT
5	REGION OF INTEREST	ROI
6	VERTEBRAL ARTERY	VA
7	NEVOID BASAL CELL CARCINOMA SYNDROME	NBCCS
8	ELONGATED STYLOID PROCESS	ESP
9	THIN FILM TRANSISTOR	TFT
10	KILO VOLTAGE	kV
11	MILLI AMPERE	mA
12	MILLI GRAY	mGy
13	SUPERIOR ARTICULAR FACET	SAF
14	VISUAL ANALOG SCALE	VAS

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INTRODUCTION

INTRODUCTION

‘‘Eyes do not read what Mind does not know”. As Bell quotes, Pain is an unpleasant experience that perhaps motivates an individual far greater than any other life experience. Pain seriously impairs the lives of millions of people around the world. Clinical pain with different circumstances may not be easily identified .The mechanisms that are involved with clinical pain appear to be different from those that cause surgical pain and are certainly not as well understood .Oro facial pain with obvious cause such as a toothache is managed with no difficulty at all. But when a pain occurs spontaneously or without evidence of structural cause, the clinician may become confused and frustrated. For the clinician to effectively manage clinical pain, he or she must have a basic understanding of the mechanisms that create this unpleasant experience. Every day, patients seek care for the reduction and elimination of pain. Nothing is more satisfying to the clinician than the successful elimination of the patient’s pain. This elimination is usually the result of some form of therapeutic intervention .Both the patient and clinician therefore tend to focus on the importance of the therapy. The most important part of managing pain, however, is in understanding the problem and establishing a proper diagnosis. It is only through proper diagnosis that the appropriate therapy can be selected.[1] Diagnosis is not easy. Too often it is overlooked or de emphasized. One difficulty that many clinicians face is his or her mechanistic approach to disease. We are often cause oriented. That’s why diagnosis is important and may become a stumbling block when dealing with obscure pain, for there may be no cause at all. As a clinician it often becomes difficult to make a diagnosis based on the clinical examination alone. Various diagnostic aids such as imaging play an essential role in diagnosis in the dental practice.[2]

As Oral physician, craniofacial pain of non odontogenic origin is often challenging.

INTRODUCTION

Craniofacial pain is a term that encompasses pain in the head, face and related structures and can originate from a variety of conditions, organs and etiologies. Many etiologies and factors can be related to cranio facial pain; however, the association between the cervical spine and its structures and craniofacial pain is a topic that is still debated. There are numerous types of association (anatomic, biomechanical, neurological and pathological) between the cervical spine and the cranio facial region. According to some studies, the cervical spine and its structures are related to the symptomatology felt by patients in the face and head.[3] Patients suffering from headaches usually fear serious brain disease. In order to manage them effectively, it is important to be aware of this match between fear of disease and its actual likelihood.

The incidence of patients suffering from chronic illnesses like cervicogenic pain, orofacialpain, tension headache have their aetiology, to be found out in routine radiological examination of head and neck structures. So we should see, analyse and perceive what pathologic event may occur or might have occurred and should be made clear in arriving at our final diagnosis for the goodness and well being of the affected individual or the patients. Normal anatomy varies among individuals and can stimulate disease. Proper diagnosis of incidental pathoses or rare normal variants is important to avoid patient mismanagement and requires familiarity with the anatomy and pathology of the head and neck region.[4]

Atlas, the first cervical vertebra is an atypical vertebra. It is named after ‘atlas’ who according to greek mythology supported the earth on his shoulders.[5] The atlas and axis permit a greater range of motion compared with normal vertebrae and are responsible for the flexing, extending, and rotation movements of the head. Atlanto axial instability is excessive movement at the junction between the atlas and the axis.[6]

Ponticulus posticus (PP) is usually regarded as a simple anatomic variant on the atlas vertebrae, it is an important, common anomaly of the posterolateral aspect of the posterior arch of the atlas and has been reported to be associated with some conditions, including vertebrobasilar in sufficiency, headache and cervical pain syndrome, migraine without aura, onset of acute hearing loss, and chronic tension type headaches.[7] The Ponticulus posticus is a bony arch on the atlas vertebrae that converts from a groove on the upper surface of the arcus posterior Atlantis to the foramen. This foramen is called the arcuate foramen and contains important anatomic structures, such as the vertebral artery and the sub occipital nerve. In addition, PP is attached to the atlanto occipital membrane, which is connected to the dura.Since PP is in an important anatomic location, there may be a relationship between the presence of PP and the associated conditions.[8] Ponticulus posticus, a Latin term that means "the little posterior bridge," is a bony bridge between the posterior part of the superior articular process and the posterolateral part of the superior margin of the posterior arch of the atlas. Although PP is usually regarded as a simple anatomic variant on the atlas vertebrae, it is an important, common anomaly of the posterolateral aspect of the posterior arch of the atlas.[9] It is necessary to sensitize oral and maxillofacial radiologist to ''see'' the skull and cervical spine and be equipped to identify variations from normal anatomy.

PP can be evaluated radiographically; radiographic examination of the cervical spine may reveal a pathological disorder in asymptomatic and symptomatic subjects.The structure can be seen on plain films of the cranio vertebral junction in the lateral projection, including the lateral cephalogram. Some studies certified that the plain cervical radiograph is not suitable for screening the ponticuli, because in some cases it is not visible and bilateralness and completeness are difficult to assess.[10]

Nowadays, cone beam computed tomography (CBCT), is the imaging modality of choice for diagnosing PP in large populations may permit more accurate determination of the demographic features and a better understanding of the causes of these lesions. Although lateral cephalography and computed tomography (CT) have been used to evaluate PP, CBCT is effective in detecting small lesions that may be unseen on planar radiographs and provides accurate finer details of the three-dimensional structures in two dimensional images. Cone-beam volumetric tomography (CBVT) or cone beam computed tomography (CBCT) has become a viable option for the dental office with the convergence of technology and affordability as compared with conventional CT.[11]

CBCT has great advantages over planar skull radiography in visualizing the cervical vertebrae. It enables depiction of the vertebral column in three planes of space, thereby providing the benefits of conventional CT with generally lower radiation exposure and greater spatial resolution. One possible explanation for differences in radiographic detection may be the use of CBCT allows the observer to view thin sections of tissue, eliminating the problem of superimposition on planar images. CBCT was chosen to make the greatest use of the advantages of each examination, and to overcome many of the shortcomings of other imaging modalities routinely used to image as isotropic voxel resolution. In CBCT the radiation doses are kept as low as reasonably achievable, quantifying the radiation dose to patients is a crucial first step in the process of developing a novel imaging technique.[12]

CBCT has low doses of radiation, a short imaging time, and better image resolution compared with CT. CBCT also produces data from all of the 2D images, including panoramic radiography, lateral cephalography, and others, and it can also create 3D images. The amount of information gained from conventional film is limited by fact that the three dimensional

anatomy of the area being radiographed is compressed into a two dimensional image. CBCT provides accurate three dimensional views of the objects examined without any distortion of the images. A major advantage of CBCT as compared to conventional CT is the reduced dosage. Though, CBCT has higher dose as compared with intra-oral radiography, the range of dose reduction is between 96% and 51% compared with conventional head CT.[13]

CBCT exposure incorporates the entire ROI only one rotational scan of gantry of 180 to 360 degree is necessary to acquire enough data for volumetric image construction. Software programmes incorporating sophisticating algorithms are applied to these projection data to generate a volumetric data set that can be used to provide primary reconstruction images in three orthogonal planes (axial, sagittal and coronal). CBCT units provide voxel resolutions that are isotropic, i.e., equal in all 3 dimensions. This produces sub millimetre resolution ranging from 0.4 mm to as low as 0.125 mm scan time is rapid as CBCT acquires all basic images in a single rotation. This leads to less motion artifacts due to reduced subject movement. Most of these pathologic conditions, developmental abnormalities, or normal variants are associated with a significant problem in other system. Interestingly, some of these findings are detectable very early in life and often precede other signs or symptoms in syndromes. Therefore, in some cases, they could potentially be valuable for an early diagnosis.[14]

This study is carried to assess prevalence of Ponticulus posticus in a series of 116 patients attending the Department of Oral Medicine and Radiology and have been advised CBCT for various reasons such as orthodontic treatment, implants, patients with chronic neck and head pain and TMJ disorders.

AIMS AND OBJECTIVES

i) Prevalence of PP in Dental patients subjected to CBCT for various reasons.

ii) To establish PP as one of the possible and causative factor for chronic head and neck pain.

iii) To assess whether the prevalence of PP is more common in males or females.

iv) To assess the most common prevalent age group with PP.

v) To assess the intensity of pain in patients with PP.

vi) To evaluate if there is any associated symptoms along with PP.

vii) To evaluate the prevalence of PP in patients without symptoms.

viii) To evaluate the frequency of association of PP with certain syndromes (Eagle's syndrome, Barre-Lieou syndrome, Nevoid Basal Cell Carcinoma Syndrome).

INCLUSION CRITERIA

i) Patients who visited to Dept of Oral medicine and radiology for various reasons such as replacement of teeth, impactions who are in need of CBCT and also patients who are experiencing cervicogenic pain subjected for CBCT.

ii) Age above 10 years.

iii) Those who gave informed consent.

EXCLUSION CRITERIA

i) Patients who are mentally challenged.

ii) Patients who are not willing to participate in the study.

iii) Pregnancy.

iv) Those who are undergoing orthodontic treatment.

v) Patients presenting with congenital anomalies such as cleft lip and palate.

vi) Patients with other syndromic conditions involving the craniofacial region and trauma in the cervical region were excluded.

vii) Occupation of the patient not included.

REVIEW OF LITERATURE

Many terms have been used in the literature to describe this anomaly, including 'foramen sagittale' and 'foramen atlantoideum posterior' were coined by Loth-Niemirycz (1916) but were never widely used. The term 'Kimmerle's variant' (Kimmerle, 1930) occurs more often in the literature. Many synonyms have been used, e.g. 'foramen retroarticular superior' (Brocher, 1955), 'canalis vertebralis' (Wolff-Heidegger, 1961), 'retroarticular vertebral artery ring' (Lamberty & Zivanovic, 1973), 'retroarticular canal' (Mitchell, 1998a) and 'retrocondylar vertebral artery ring' (Mitchell, 1998*b*).[15] The most commonly accepted name is **Ponticulus posticus**.

The origin of this anatomical variation of the atlas remains unclarified. Many authors suggested that it is a congenital characteristic while others suggested that it is a genetic trait since they observed a familial appearance of Ponticulus posticus.[16] Another possible explanation is the ossification of the posterior atlanto occipital membrane due to aging while there is a theory that supports that external mechanic factors could lead to the development of ossification over the vertebral artery groove. Finally, many authors describe Ponticulus posticus as a regressive and disappearing morphological phenomenon since its occurrence is prevalent in early primates.[17]

Various hypothesis and theories were put forward on Ponticulus posticus.

Ponticulus-posticus occur as a result of ossification of free margin of oblique part of posterior atlanto-occipital membrane which may cause external pressure on vertebral artery especially during extreme rotatory movement of head (Lamberty and Zivanovic 1973, Taitz and Nathan 1986, Mitchell 1998). The embryologic origin of the anomaly is discussed that the presence of lamellar patterns within the bone matrix and a cortex indicating endochondral ossification suggest that it may originate from the dorsal arch of proatlas.[18]

Some studies suggested that it may be the products of congenital development, a genetic trait, ossification due to age or result of external mechanical factors (Selby et al.1955, Pyo and Lowman 1959, Taitz and Nathan 1986).

Vestigial expression of a primitive occipital vertebra or of a proatlantal element was evoked theoretically by many authors to explain the presence of the dorsal and the lateral ponticles, but without morphological or biological demonstration (Bolk, 1906; Swetschnikow, 1908; Hayek, 1927; Ingelmark, 1947; Schmidt, 1959; Wackenheim, 1974; Kittel, 1985) the dorsal and lateral ponticles were the result of an ossification of fibrous tissues occurring with aging, sometimes compared to osteophyte formation (Taitz and Nathan, 1986) no difference in occurrence according to age in adults has been demonstrated (Kendrick and Biggs, 1963; Sato and Noriyasu, 1978; Dugdale, 1981).

The vertebral artery passes near the posterior arch of the atlas, and impressing a groove in the bone. If the fibrous ligament of the condyle is ossifies, the groove can transform in a hole-channel, this determining an entrapment of the vertebral artery with the venous plexus and the sub occipital nerve.[19] LeDouble described that pulsation of vertebral artery induced the ossification of the ligament and also mention that such type of bony ring formation could not occurs simply due to ossification of the ligament but it occurs as a result of a regressive and disappearing morphological phenomenon.[20] This hypothesis was further supported by Lamberty and Zivanovic, who reported these posterior ponticuli in skeletons of two children aged 2 and 4 years and explained that ossification of the ligaments never occur in such young groups of people. Taitz and Nathan proposed a hypothesis that the development of the bony ponticuli may be due to external mechanical factors like carrying heavy objects on the head which was supported by Paraskevas G et al.

Some of the earliest writings on the subject of Ponticulus posticus are said to date back to Dutch anatomist Louis Bolk in1906. In addition, Ponticulus posticus has been found on human skeletons dating back to the12th century.[21]

PREVALENCE

There have been several studies regarding PP prevalence from the earliest civilization starting from the examination of cadavers to radiological examination including CBCT at present.

In 1955 Selby et al, conducted study in North America using lateral radiography to assess the prevalence of PP and the prevalence was found to be 27%.

In 1959 Pyo and Lowman conducted study using lateral radiography to assess the prevalence of PP and it was 12.67%.

In1963 Kendrick and Biggs conducted study in North American orthodontic patients using lateral radiography and the prevalence of PP was found to be 15.86%.

In 1973 Lamberty and zivanovic conducted study in England and prevalence of PP 13.64%.

In 1978 Saunders and popovich in Canada population using lateral radiography to assess the prevalence of PP and it was 29.22%.

In 1979 Farman et al in South Africa using lateral radiography to assess the prevalence of PP and it was 26.82%.

In 1981 Dugdale using lateral radiography to assess the prevalence of PP it was 15.51%.

In 1986 Taitz and Nathan conducted study in cadaver to assess the prevalence of PP 33.78%.

In 1988 Ruprecht et al conducted study in Saudi Arabian orthodontic patients using lateral radiography to assess the prevalence of PP 32.94%.

In 1992 Hoenig and Schoener conducted study in Germany in 30 cleft lip and 30 normal patients using lateral radiography to assess the prevalence of PP 21.67%.

In 1992 Stubbs in North America using Lateral radiography to assess the prevalence of PP 18.70%.

In 1993 Dhall U.et al.studied 148 vertebrae in that he found 41 posterior ponticuli (27.70%).

In 1999 Wight et al., conducted study using Lateral radiography in Scottish Chiropractic patients with headache prevalence 17.99%.

In 2001 Hasan et al., conducted study using Cadaver in Northern India which showed a prevalence of 6.57%.

In 2001 Manjunath, conducted study using Cadaver in Southern India with 11.70% prevalence.

In 2005 Cakmak et al., conducted study using Lateral radiography in Turkey showed 13.46% PP prevalence.

In 2005 Paraskevas et.al., conducted study using Cadaver in Northern Greece with 34.66% prevalence.

In 2005 Young et al., conducted study using Cadaver in North America showed 15.00% prevalence.

In 2007 conducted study using Krishnamurthy et al., using Cadaver in India and the prevalence was 13.79%.

In 2007 Tubbs et al., conducted study using Cadaver in North America showed 5.00% prevalence.

In 2007 Kim et al., conducted study using Lateral radiography in Korean orthodontic patients with prevalence rate of 14.10%.

In 2007 Kim et al, conducted study using CT in Korean patients with cervical symptoms

Showing 25.78% PP prevalence.

In 2008 Simsek et al., conducted study using Cadaver in Turkey and gave out results showing 9.49% PP prevalence.

In 2008 Hong et al., conducted study using CT Korean patients with CT angiography of neck amounting to 15.60% of PP prevalence.

In 2010 Sharma et al., conducted study using Lateral radiography in Indian orthodontic patients with a prevalence of 4.31%.

In 2012 Yeom et al., conducted study using CT in C1-C2 posterolateral fusion (Harms procedure) with prevalence of 17.31%.

In 2013 Chitroda et al., conducted study using Digital lateral Cephalography in Gulbarga population resulted in 68.40% PP prevalence.

AGE

Studies have also been conducted for identifying the age group prevalence of PP in the medicine history.

Formation of incomplete posterior ponticle can be explained by disappearance of middle part of posterior bridge first and it may be precursor of a complete bridge.[15]So incomplete ponticle is a characteristic feature of younger age group (10-30 years) and complete bridges predominate in 30 to 80 years. The percentage of complete form increases with age, especially between 16 and 45 years.[22]

In 1963 Kendrick and Biggs studied the lateral cephalometric radiographs of 353 young Caucasian orthodontic patients aged 6 to 17 years for the presence of the same entity of the subjects, 15.8% showed some degree of PP, with no apparent sex predilection (14.6% males and 16.9% females). The youngest female with PP was aged 6 years 7 months, and the youngest male was aged 6 years 4 months. This proves again that higher age is not a criterion for the formation of ponticulus.

The bony ring was observed in the atlas vertebra of two skeletons aged two and four years and also in the x ray of cervical spine of a 13 year old boy. Ossification of the ligament did not normally occur in such young persons.[23]

Some studies suggested that it may be related to aging (Taitz and Nathan 1986, Paraskevas et al. 2005) but contrary to it some observed that there was the presence of ponticulus-posticus cartilage in foetuses and children also which totally rules out the possibility of ossification with age (Lamberty and Zivanovic 1973).Paraskevas G mentioned that there was a higher occurrence of partial PP in the 5-44 years of age group.[24]

Several studies for diagnosing PP prevalence in radiology were conducted using the conventional lateral cephalogram to the latest CBCT up to date

In 1987 Radiographic study done by Roy revealed the presence of bilateral complete, bilateral incomplete, unilateral complete and unilateral incomplete in Ponticulus posticus.

In 2004 Erdogan unur, evaluated PP in Lateral cervical spine radiographs with clinical complaints such as vertigo, neck pain or discopathy were reviewed in the Radiology Department of the University Hospital ,Turkey over a 3 month period.[25]

In 2005 Young et al., using Lateral radiography of North America population for the presence of PP. PP was almost equally detected on both the left and right sides. This was not clearly identified in the plain radiographic studies because plain film studies fail to differentiate between the right and left. In previous cadaveric studies, there was no difference between the two sides.[26]

In 2007 Jae take hong done a study in Korean population consisted of a review of the records of 1013 Korean patients who underwent CT angiography for reasons other than evaluation of Vertebro artery disease. The prevalence of a posterior ponticulus in these Korean patients was 15.6%.[27]

In 2010 Sharma et al. Studied the lateral cephalometric radiographs of Indian orthodontic patients aged 8–22 years for the presence of PP of the first cervical vertebra. In their study, complete PP was found in 4.3% of the subjects.[18]

In 2012 J R Geist et al done study with Cone beam CT scans of patients were examined for PP. Overall prevalence of PP was 26.2%, with complete lesions in 10.4%.[28]

In 2013 Ibrahim Sevki Bayrakdar et al., Analysis of CBCT images in Turkish population revealed PP.[29]

In 2014 Ahmet Ercan Sekerci a retrospective study composed of the CBCT images of patients who presented to the Dentomaxillofacial Radiology Erciyes University, Kayseri, Turkey.

In 2014 Myoung Soo Kim retrospectively reviewed cervical 3-dimensional (3D) CT images. One hundred and eight vertebrae (108/1029, 10.5%) showed an arcuate foramen.[30]

ASSOCIATED SYNDROMES WITH PP

Studies have also been made on the syndromes that were associated with the PP and conditions that were related it.

In 1957 Tatlow and Bammer were, among the first who reported several cases of Barré-Lieou syndrome to be due to VA compression by the PP—a view that has gained considerable support in more recent years because the logical progression of such a scenario was that surgical excision of the PP should decompress the VA and, therefore, alleviate the symptoms.[31] Lamberty and Zivanovic, identify the PP as the causative factor in headaches, vertigo, Barré-Lieou syndrome, “eye” pain, and photophobia. The mechanism is unclear, although it is thought by some to be due to compression of the vertebral artery (VA) by the PP, leading to ischemia of the vertebrobasilar circulation.[32]

In 1972, Graham and Adams, as described by Eriksen, reported two cases of thrombosis of the vertebrobasilar arterial system in the absence of identifiable arterial disease, but in the presence of Ponticulus posticus. White and Panjabi pointed out the stretching and kinking effect on the vertebral artery with head rotation.[18]

Ponticulus posticus has been described in classical literature as an anatomical variation in human beings having a strong relation to the passage of vertebral artery and also associated with numerous clinical conditions like cervical pain, headache and dizziness (Wight et al. 1999, Cakmak et al. 2005).

One of the possible mechanisms for cleft palate development is represented by the congenital anomaly of the vertebral spine. Association between the prevalence of upper cervical vertebrae anomalies and cleft lip/palate, which is not gender dependent.[33] Presence of a PP in cleft lip and palate (CLP) individual should influence the patient positioning at the time of surgery because; traditionally, the surgical approaches of cleft repair start with a supine patient with the head on an adjustable rest and a roll placed under the shoulders with the neck in variable degrees of extension, and some surgeons prefer to operate with the neck in full extension, nearly to the point that the head is sitting in the surgeons lap and it is possible that such extension of the neck in combination with the PP could lead to bilateral occlusion of the vertebral artery and ischemic injury of the posterior fossa which could be a cause of death.[34]

In 2006 Rosalia Leonardi et al studied 22 patients (14 males and 8 females), with the diagnosis of NBCCS seen between 1990 and 2006. Lateral and frontal cephalometric radiographs of 18 patients the diagnosis of Nevoid Basal Cell Carcinoma Syndrome (NBCCS) were evaluated for the presence of intracranial calcifications (diaphragma sellae and falx cerebri) and or calcification of the atlanto-occipital ligament. A total of 11 patients presented calcification of atlanto-occipital ligament to various degrees patient affected by NBCCS showed an increased prevalence of atlantooccipital ligament calcification than is found in the general population.[35]

A.E. Sekerci et al. 2015 did first study investigating the relationship between the two disorders Ponticulus posticus and elongated styloid process (PP and ESP) in the literature. There were no statistically significant differences in length values of ESP between males and females in either group. There was a significant relationship between the presence of PP and ESP.

MATERIALS AND METHODS

- This is a prospective descriptive study of Ponticulus posticus.
- Using non randomised convenience sampling and sample size was 116 including 66 males and 50 females aged between 11 to 80 yrs.
- Ethical approval was obtained from institutional ethical committee.(Annexure I)
- Informed consent was taken from all the patients after explaining the aim and methodology.(Annexure II)
- Detailed examination of the patient was carried out who reported in Department of oral medicine and Radiology, Best Dental Science College Madurai.(Annexure III)
- Intensity of pain was assessed using Visual Analog scale.
- CBCT images were performed in Surya dental scan in Madurai between 2015 and 2016 in patients who reported in Department of oral medicine and Radiology, Best Dental Science College, Madurai and Other patients were also referred from Department of Oral and Maxillo Facial Surgery, Prosthodontia and Orthodontia for CBCT imaging.
- All the images were performed through the same equipment.
- In detail, the 116 cone beam computed tomography images were assessed by researcher and by another observer (Guide), to verify possible error.
- The information collected regarding all the selected cases were recorded in a Master Chart in Excel sheet.(Annexure IV)

- Data analysis was done with the help of computer using SPSS statistical package- Version 19.

Continuous variables like age were expressed as range, mean and standard deviation and categorical variables like gender, nature and intensity of pain, diagnoses etc were expressed as frequency and percentage.

Unpaired Student's't' test was used to test the significance of association between incidence of Ponticulus Posticus and quantitative variables and Yate's or Fisher's chi square test for qualitative variables. A 'p' value less than 0.05 was taken to denote significant difference.

Fig 1. CS 9300 CBCT machine General functional components

1. ON/OFF button 2.Unit fixed arm 3.Control Panel 4.Hand Grips

5. Chin rest base 6.Temple Supports 7.Sensor 8.X-Ray source assembly

9. Unit rotative arm

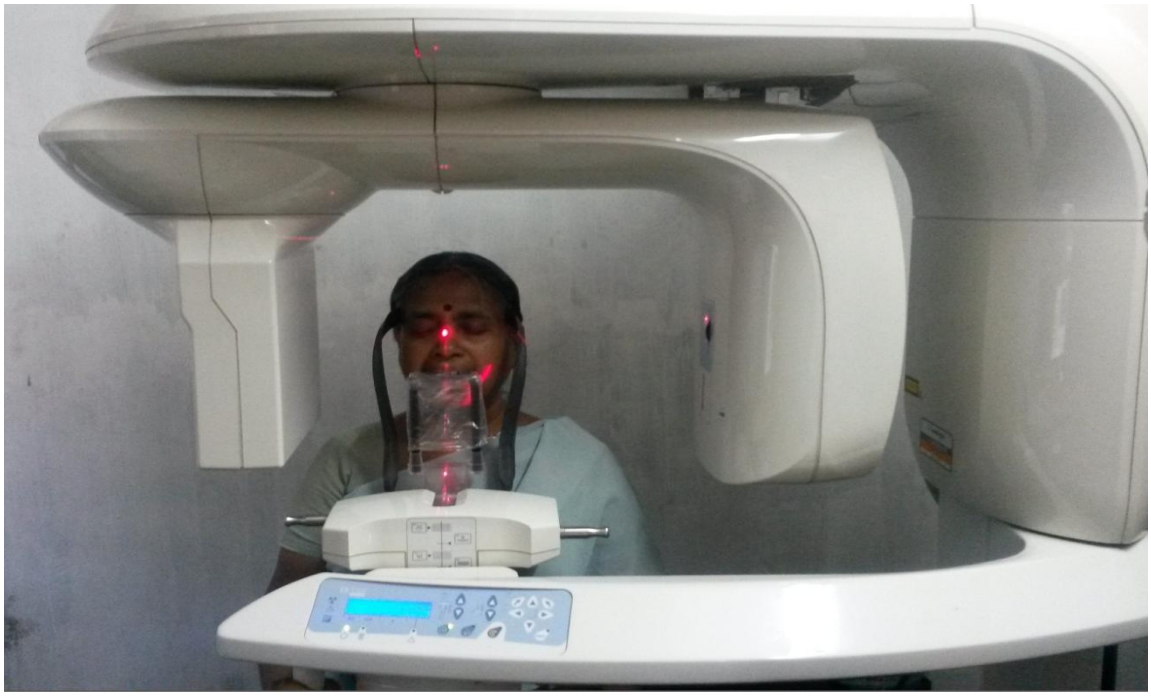


Fig 2. Preparation of the adult patient while imaging

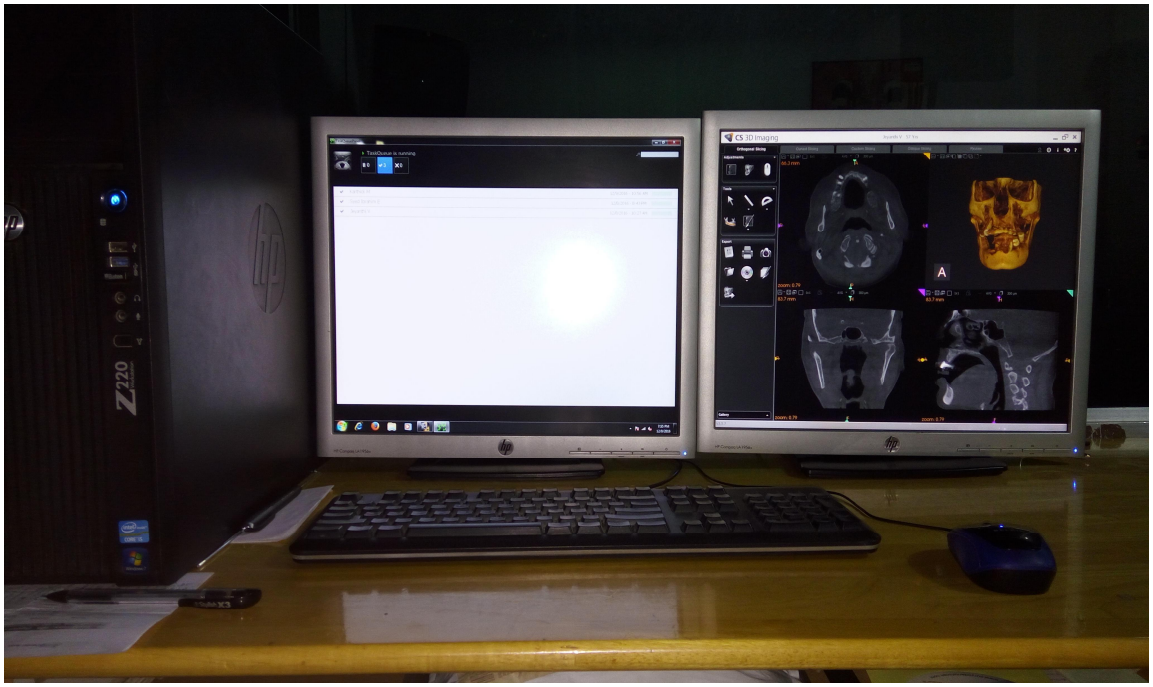


Fig 3. Computer hosting the imaging and the acquisition software

Technical Specifications

Company	:	KODAK CS 9300
Country	:	USA
Software used	:	CARESTREAM (CS3D)
Sensor type	:	TFT
Scan mode	:	continuous and pulse
Field of view	:	17 x 11 (cm)
Voxel size	:	300
Tube voltage	:	85 kV
Tube current	:	4.0 mA
Exposure time	:	11.30 seconds
Exposure	:	1359 mGy.cm^2

Imaging acquisition and analysis

The CT images were obtained by using a CBCT unit (CS9300 KODAK, USA) with default parameters (85 kV and 4.0 mA, scanning time 11.30 seconds; imaging field of view, 17x11 cm, pixel resolution 0.4/0.4 mm; slice thickness, 0.4 mm. The occlusal plane of each patient was set parallel to the horizontal plane by using a chin rest. The axial images were reconstructed to generate multiplanar reformatted coronal and sagittal images. The bilateral parasagittal views with 15 mm in thickness were displayed in maximal intensity projection

mode. Reconstruction time less than two minutes based on the recommended computer system configuration. Scan data were reconstructed and images were viewed with care stream software on a flat screen with 1024 x 768 spatial resolution. Ponticulus posticus was evaluated by scrolling from right to left on the sagittal view.

The images were reconstructed into 3-D images and carefully inspected for the presence of a PP and whether it was complete are partial.

Patients were stratified into six age groups .11 to 20 years, 21 to 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years and above 60 years.

The right and left sides of each atlas were categorized as to the presence or absence of PP using the following classification, modified from cederberg et al and Stubbs.

Class 1: no calcifications across the pathway of the vertebral artery

Class 2: calcification extending less than halfway across the artery

Class 3: calcification extending at least halfway but not completely across the artery

Class 4: calcification extending completely over the pathway of the artery

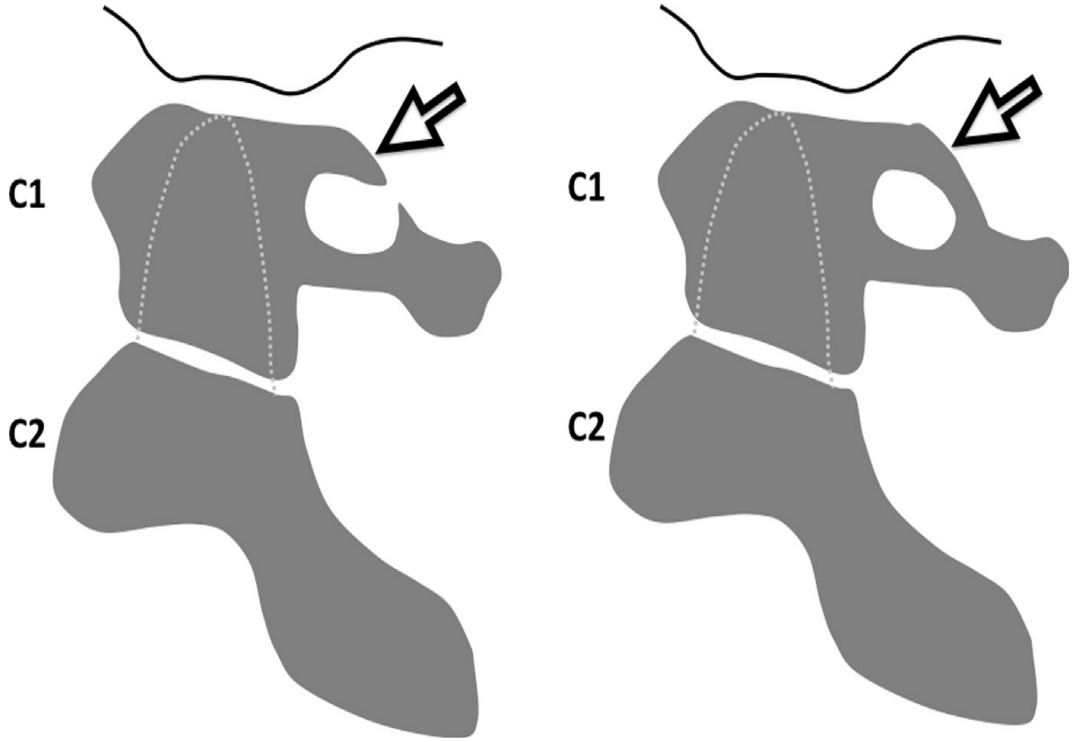


Fig 4. PONTICULUS POSTICUS PARTIAL AND COMPLETE

COURTESY: Juan Schilling et al.(2010)

Superior articular facet (SAF)

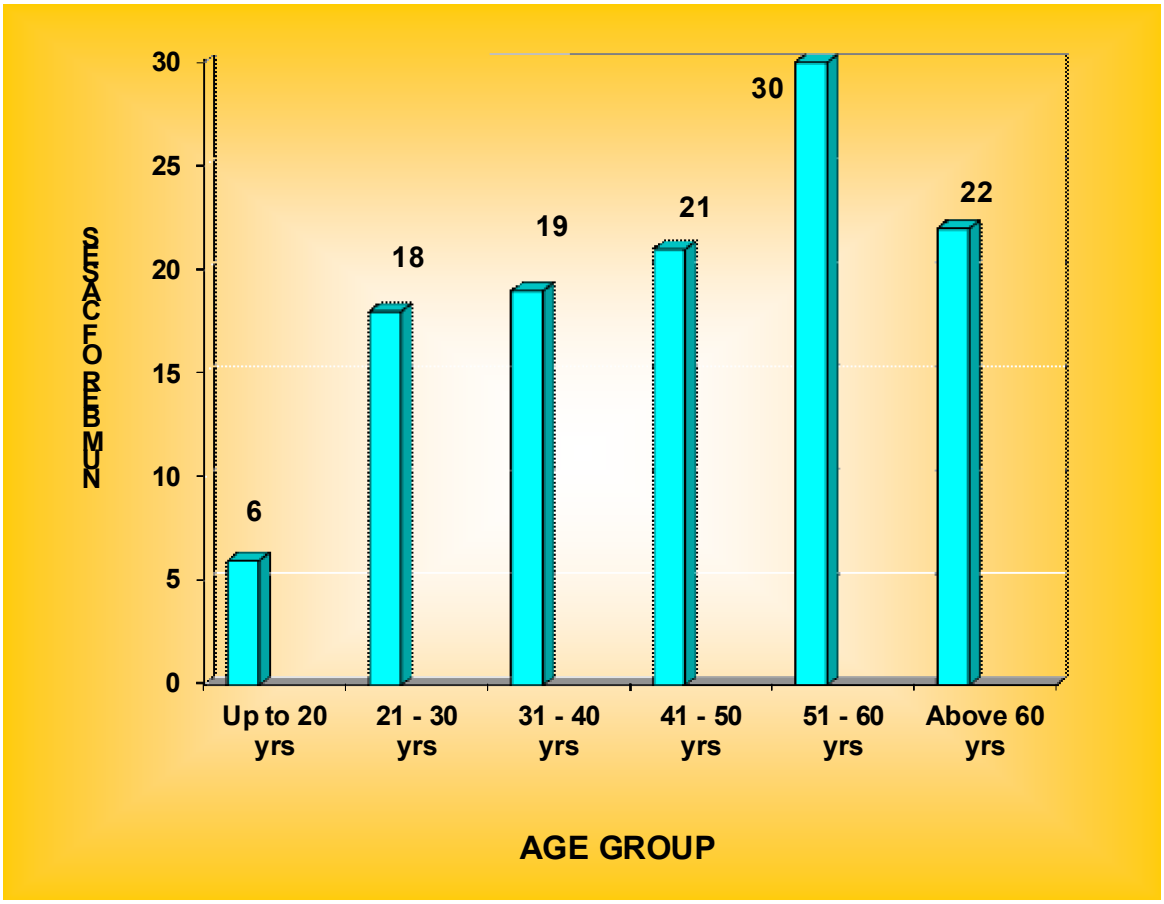
The dimension and area differences of the atlas SAF between PP and non-PP sides were analyzed. The measurement of the area was performed on the axial view that was selected with a 10-mm thickness and magnification. The maximum dimensions of the SAF in the long axis of anteroposterior dimension (D1) and long axis of transverse dimension (D2) were measured. The cross-sectional areas of the SAFs were calculated from the earlier measurements using the formula for the area of an ellipse

$$\text{Area} = \pi \times D1 \times D2 \times 1/4.$$

The differential ratio of SAF area in the patients with unilateral PP was calculated by the area difference between the PP and non-PP sides divided by the area on the non-PP side.

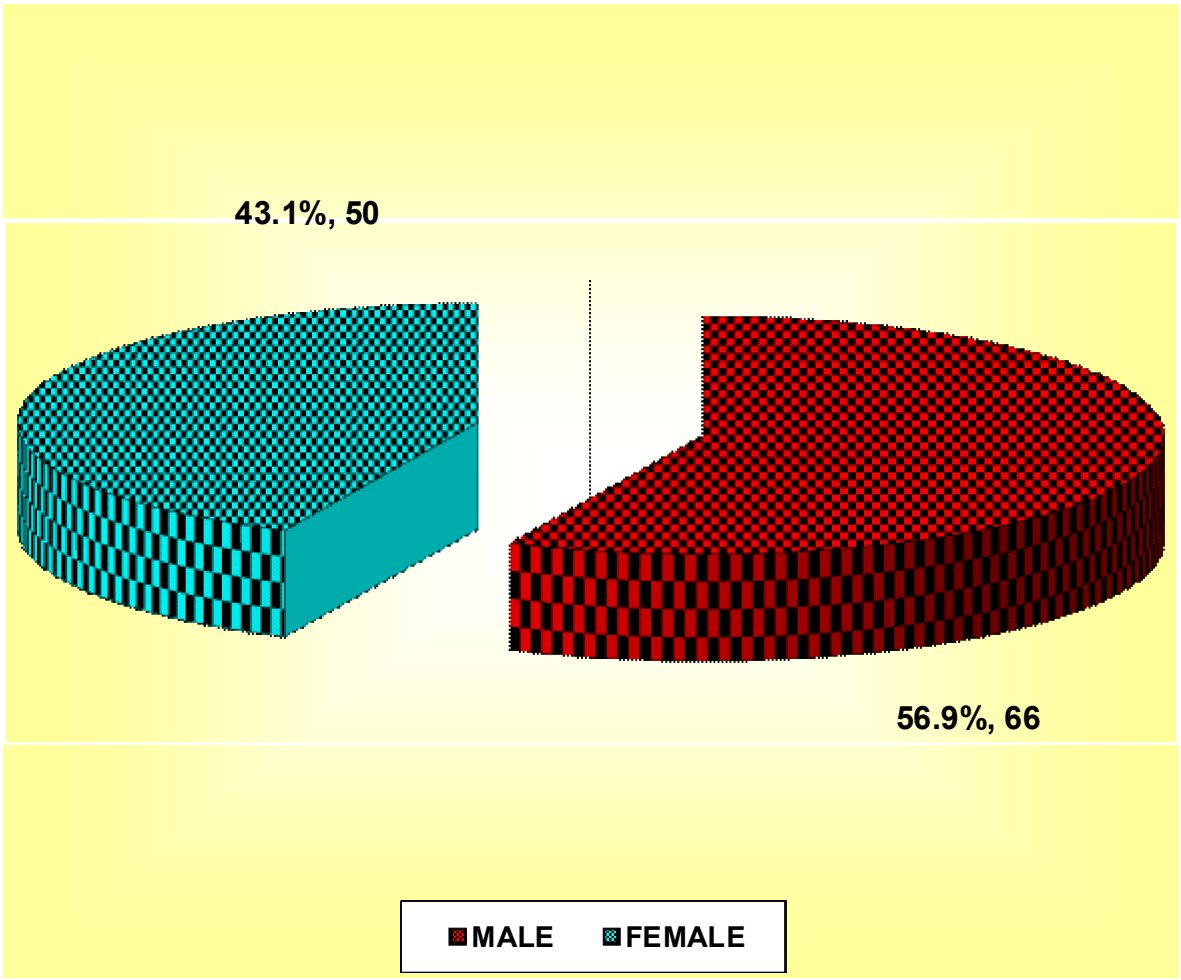
RESULTS

GRAPH 1: Age distribution



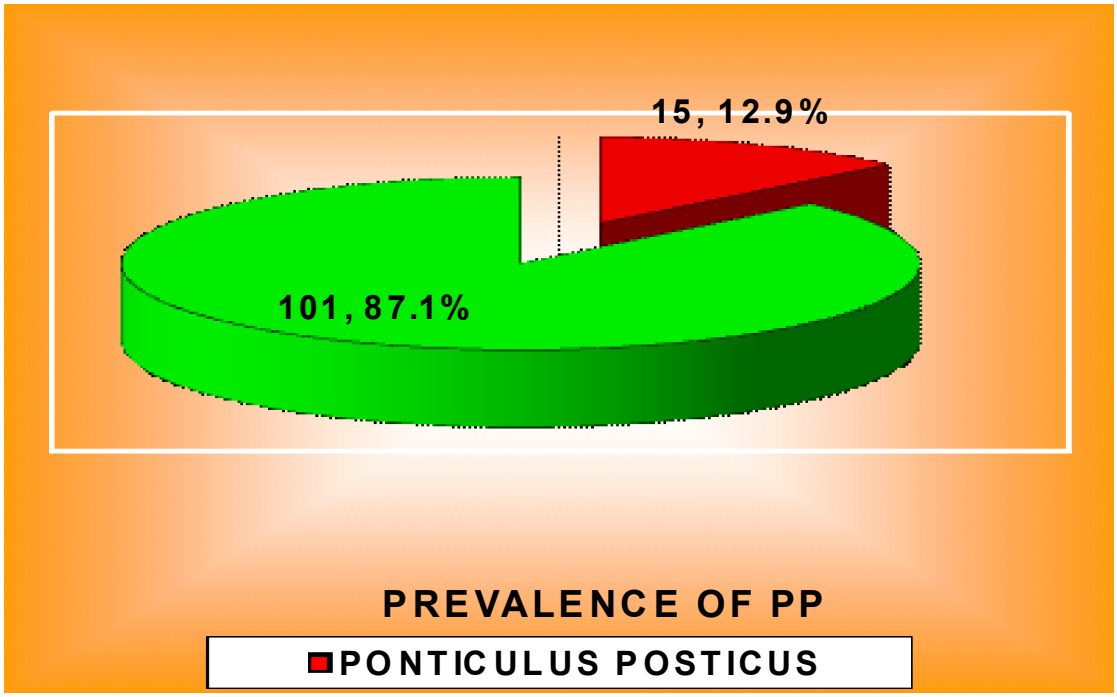
Graph 1 tells about the age distribution of the samples collected for the study. Over all 116 patients were screened for the study within a range of 12-77 years with a mean age of 46 years with in a standard deviation of 14.8 years. The patients were divided into 6 groups each having a distance of a decade from below 20 to above 60 years. 6 patients were below the age group of 20 years accounting to 5.2 %.18 patients were in their third decade of life making up to 15.5 %, 19 patients were in their fourth decade of life counting up to 16.4 %.21 patients were from the fifth decade of life accounting up to 18.1 %.The highest no of patients were from the sixth decade about 30 in number accounting up to 25.8 % and finally 22 patients were above sixth decade of life accounting up to 19 %.

PIE DIAGRAM 1: Sex Distribution



Pie Diagram 1 shows the sex distribution of the subjects taken for the study. There were 66 males and 50 females among the study population accounting up to 56.9% and 43.1 % respectively.

PIE DIAGRAM 2: Prevalence of PP



The Pie diagram 2 shows the overall prevalence of PP in the total study population of 116 patients. Only 15 patients exhibited PP and 101 patients were negative for PP giving a result of just 12.9 % as positive prevalence of PP excluding the remaining 87.1%.

TABLE 1: Age and Sex with incidence of Ponticulus Posticus

Characteristics (Patients Studied)			Patients with PP(n=15)		Patients without PP(n=101)		't' value/ Chi square	'p' value
			Mean Age 38.5±15.5 yrs		Mean Age 42±14.5 yrs			
Age (yrs)	**No. of Patients**	**Percentage**	**No. of Patients**	**Percentage**	**No. of Patients**	**Percentage**		
11 to 20 yrs	6	100%	2	33.3%	4	66.7%	2.11	**0.0368 Significant**
21 – 30 yrs	18	100%	4	22.2%	14	77.8%		
31 – 40 yrs	19	100%	2	10.5%	17	89.5%		
41 – 50 yrs	21	100%	4	19%	17	81%		
51 – 60 yrs	30	100%	2	6.7%	28	93.3%		
>60yrs	22	100%	1	4.5%	21	95.5%		
Gender								
Female	50	100%	8	16%	42	84%	0.3341	0.2041 Not significant
Male	66	100%	7	10.6%	59	89.4%		

Table 1 shows the prevalence of Ponticulus posticus age wise with sex distribution. The mean patient ages were 38.5 ± 15.5 yrs with Ponticulus posticus and 42 ± 14.5 yrs without Ponticulus posticus. In the second decade of life 33.3 % of patients had PP .In the third decade 22.2 % of the patients had PP. Almost 10.5% had PP in the fourth decade of life. In the fifth decade 19% of the subjects had PP. In the sixth decade 6.7% had PP. Above 60 years had a minimal prevalence of 4.5% all the above details were calculated with the help of chi square test. The 'p' value is 0.0368 which shows significant.

On analyzing the sex distribution 16 % of the patients had PP among the females. A total of 10.6% of patients had PP in males. The 'p' value among the sex distribution 0.2041.

TABLE 2: Intensity of pain and incidence of Ponticulus Posticus

Intensity of pain (according to VAS scale)	Total.No.of Patients	Ponticulus Posticus			
		Positive		Negative	
		No. of Patients	Percentage	No. of Patients	Percentage
Mild	14	6	42.9%	8	57.1%
Moderate	6	5	83.3%	1	16.7%
Chi square	1.3853				
'p'	0.0656 Not significant				

Table 2 shows the intensity of pain and the prevalence of PP in the study subject. The intensity of the pain was calculated by visual analog scale. Out of 116 patients a total of 20 patients had pain ranging from mild to moderate, and they were further screened for the presence of PP or not. After the screening 42.9 % of the patients who were positive for PP exhibited mild pain and 83.3 % had moderate pain.

Among the negative patients with PP prevalence 57.1 % had mild pain and 16.7 % had moderate pain.

The chi square test value was 1.3853 and the p value was 0.0656 and is not significant.

TABLE 3: Association of symptoms and incidence of Ponticulus posticus

Association of Symptoms	Total No. of Patients	Ponticulus posticus			
		Positive		Negative	
		No. of Patients	Percentage	No. of Patients	Percentage
Symptomatic group (Including Eagle's syndrome-3)	20	11	55.0	9	45.0
Asymptomatic group	96	4	4.2	92	95.8
Chi square	33.61				
'p'	**0.0001 Significant**				

Table 3 shows the Association of symptoms and incidence of Ponticulus and posticus in the study subjects who were PP positive and negative. A total of 55 %(20) of the patients were symptomatic out of the 116 and the remaining 96(45%) patients were asymptomatic. Among the symptomatic group 11 patients i.e. 55% where positive for PP and 9 patients i.e. 45% of patients were negative for PP. In the asymptomatic group 4 (4.2 %) patients were positive for PP and 92 (95.8%) of the patients were negative for PP. The statistical calculation done by chi square test showed a 33.61% of the incidence of PP and the significant 'p' value is < 0.0001.

TABLE 4: Cederberg et al Classification stating the presence or absence of PP radio graphically

Cederberg et al Classification	Cases	
	No	**Percentage**
Class 1	**101**	**87.1%**
Class 2 Class 3 Class 4 Class 2 (Rt) & Class 4 (Lt)	5 3 6 1	4.3% 2.6% 5.2% 0.8%
(Class2, Class3, Class4) With PP Total	**15**	**12.9%**
Total	**116**	**100%**

Table 4 shows the prevalence of PP radiographically according to the cederberg et al classification. The cederberg et al classification says there are four classes of PP prevalence. According to the cederbrg et al classification radigraphically

Class 1: no calcifications across the pathway of the vertebral artery

Class 2: calcification extending less than halfway across the artery

Class 3: calcification extending at least halfway but not completely across the artery

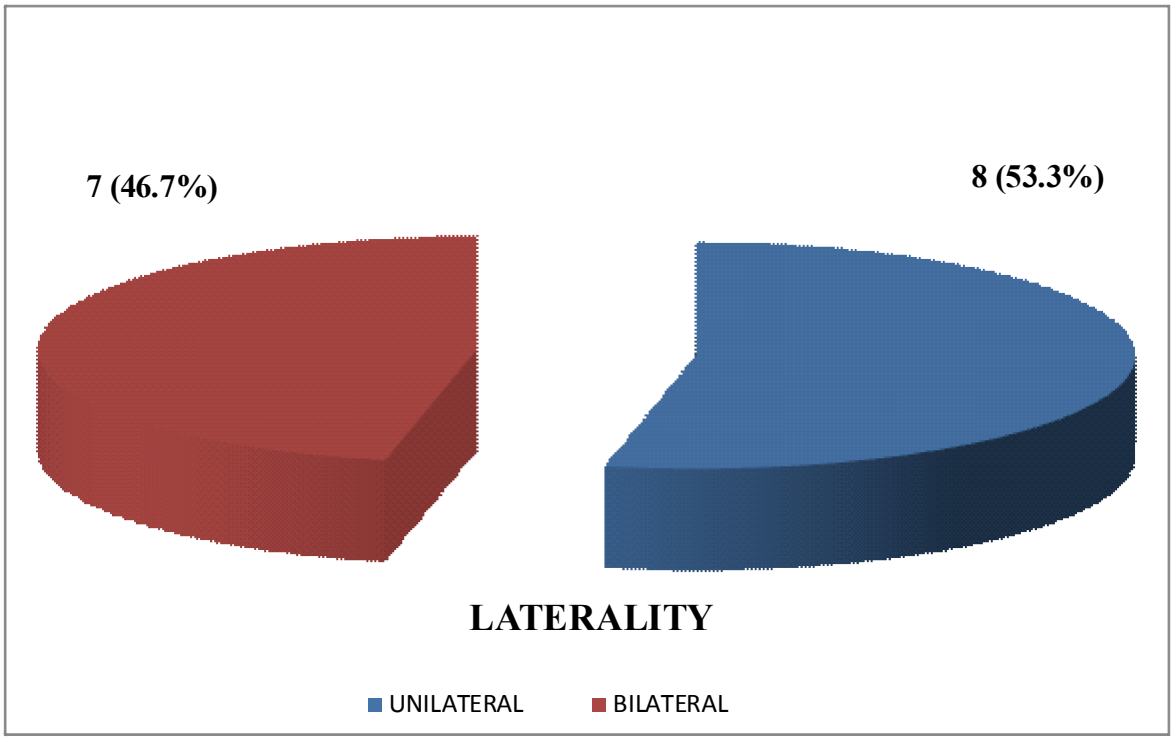
Class 4: calcification extending completely over the pathway of the artery

On screening a total of 12.9% of the study group had PP. The 15 subjects who had PP were classified according to the cederberg et al and tabulated.

Class 1 - 87.1% Class 2 - 4.3 % Class 3 - 2.6% Class 4 - 5.2%

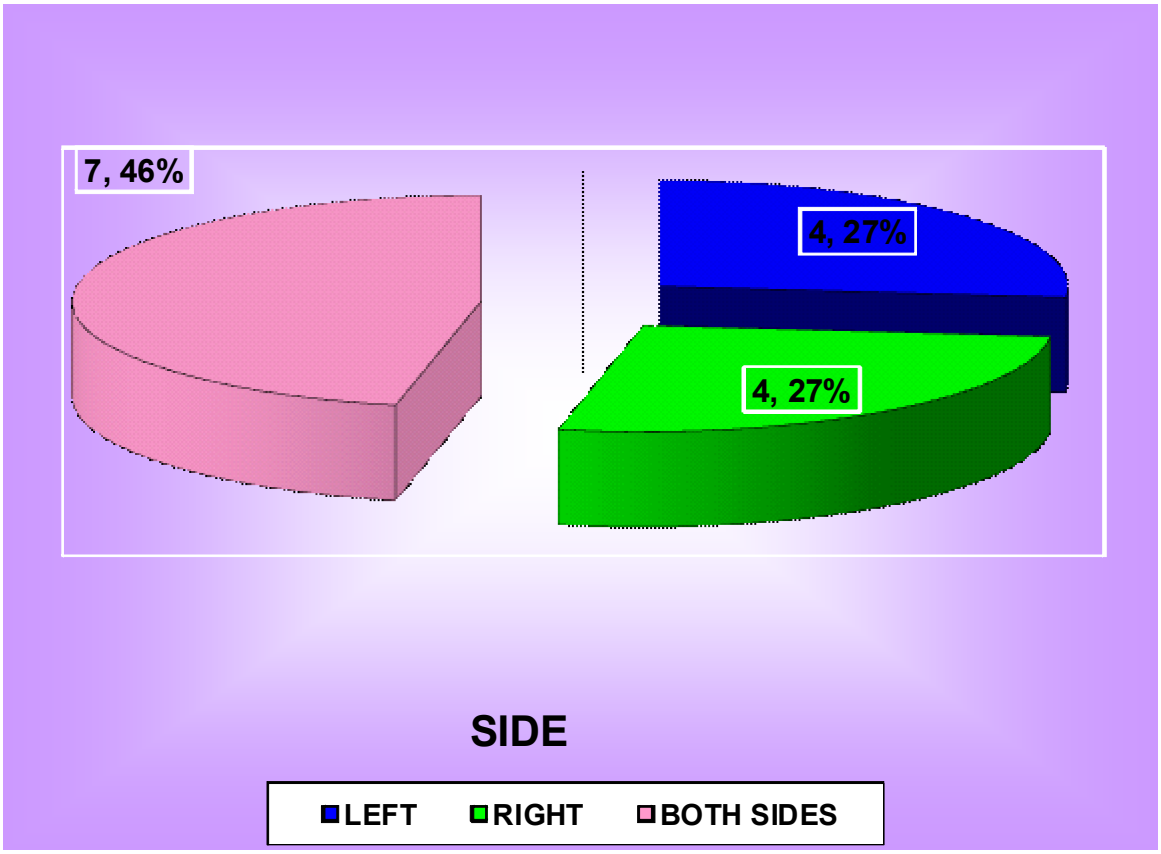
One patient had a combination of class 2 on the right side and class 4 on the left side accounting up to 0.8 %.

PIE DIAGRAM 3: LATERALITY



The patients had both unilateral and bilateral prevalence of PP which is discussed in Pie Diagram 3. Out of the 15 patients who had PP, 8 patients (53.3%) had unilateral PP and 7 patients (46.7%) had bilateral prevalence of PP. There is almost no significant difference in the laterality.

PIE DIAGRAM 4: SIDE (for positive cases)



The side of prevalence of PP in the unilateral and bilateral cases is explained in the pie diagram 4. On radiological observation and based on the laterality of PP prevalence, 8 patients were unilaterally having PP and 7 patients had PP bilaterally. In the unilateral patients who were 8 in number 4 patients exhibited PP in the left side and the remaining 4 patients exhibited PP in the right side amounting to 26.6% equal distribution of PP on both right and left side.

TABLE 5: Patients with Different Types of PP and Its Distribution

Laterality	Complete Type		Partial Type	
	No. of Patients	Percentage	No. of Patients	Percentage
Bilateral (n=7)				
Homogenous(n=6) Heterogeneous (n=1) (Different Class on each side)	2 1	33.3% 100%	4 -	66.7% -
Unilateral (n=8)	4	50%	4	50%
Total (n=15)	7	46.7%	8	53.3%

Table 5 shows the distribution of the different types of PP among the 15 patients who were positive for PP. A total of 7 patients (46.7%) had complete type PP and 8 patients (53.3%) had partial type PP. There is increased distribution of PP in the partial type up to 66.7% bilaterally whereas there is equal distribution of PP in the unilateral type.

The distribution was tabulated according to the homogeneity i.e. the prevalence of same class of PP on both sides is considered to be homogenous and different class on each side is considered to be heterogeneous. In the bilateral group of patients 2 (33.3%) patients were having a homogenous distribution of complete type and 1 patient (66.7%) was heterogeneous with complete fusion on the right side and partial fusion on the left side.

TABLE 6: Association of symptoms and types in patients with PP

Association of Symptoms	Total. No. of Patients (n=15)	Types in patients with PP			
		Complete		Partial	
		No	%	No.	%
Symptomatic	11	6	54.5	5	45.5
Asymptomatic	4	1	25.	3	75.0
Chi square	0.1842				
'p'	0.3385 Not Significant				

Table 6 shows the association of symptoms in the different types of PP positive group .The symptoms were classified under the complete and partially fused PP patients. There were totally 11 patients symptomatic out of 15 positive patients and 4 were asymptomatic.

In the symptomatic patients 6 (54.5%) patients had complete type of PP and 5 (45.5%) patients had partial type of PP. Among the asymptomatic group 1 (25%) had complete type of PP and 4 (75%) patients had partial type of PP. The chi square test p value is0.1842.

TABLE 7: Age group and types in patients with PP

Age group	No. of Patients	Types in patients with PP			
		Complete		Partial	
		No	%	No	%
11 to 20 yrs	2	1	50.0	1	50.0
21 – 30 yrs	4	4	100.0	-	-
31 – 40 yrs	2	-	-	2	100.0
41 – 50 yrs	4	1	25.0	3	75.0
51 – 60 yrs	2	1	50.0	1	50.0
>60 yrs	1	-	-	1	100.0
Total	15	7	46.7	8	53.3

Table 7 shows the different types of PP in different age groups. Out of 15 patients 2 patients were below 20 years with 1patient each in complete and partial type. There were 4 patients in the third decade with complete type of PP. In the fourth decade of life 2 patients were in the partial group. In the fifth decade 1 patient was in the complete and 3 patients in the partial group. in the sixth decade 1 patient is in the complete group and 1 patient in partial group. Above the age of 60 1 patient was in the partial group.

So totally there were 7 (46.7%) patients in the complete group and 8 (53.3%) patients in the partial group showing that there is the second and fourth decade of life. And there is no significant predilection for the age group for the partial and complete types exhibition of PP age wise.

TABLE 8: Superior Articular Facet Dimensions

Variable	P.P.Side		Non P.P.Side		'p' Value
	Mean	S.D	Mean	S.D	
COMPLETE					
D1	21.7	1.9	21.0	1.0	0.578
D2	14.1	2.2	13.8	1.9	0.8447
Area	241.6	58.4	228.2	19.6	0.7163
PARTIAL					
D1	22.4	1.3	21.9	1.4	0.6154
D2	13.7	1.4	13.3	0.7	0.675
Area	239.8	23.9	228.7	18.5	0.4915

Table 8 shows the mean anteroposterior dimension, transverse dimension, and area on the PP side compared with those on the non PP side complete PP (21.7 vs. 21.0 mm, 14.1 vs. 13.8 mm, and 241.6 vs. 228.2 mm^2) respectively and in the unilateral partial PP (22.4 vs.21.9 mm,13.7 vs. 13.3 mm, and 239.8 vs. 228.7 mm^2) respectively.

DISCUSSION

The concept of pain has evolved from that of a one dimensional sensation to that of a multidimensional experience encompassing sensory-discriminative, cognitive, motivational, and affective qualities. Chronic headache is recognised as a symptom, it may be due to generalised musculoskeletal disease, neurological diseases or from other sources like normal anatomical variant.[36] The Ponticulus posticus is an ossification of the oblique atlanto-occipital ligament superior to the VA groove of the atlas, compression of the nervous and vascular structures passing through the foramen may result in a combination of symptoms forming a picture of vertebro basilar insufficiency.[37] This consists of cervical migraine, neurosensory-type hearing loss, neck pain, vertigo, shoulder/arm pain and, in some instances, even loss of postural muscle tone and consciousness.[38] Since anatomical variant such as Ponticulus posticus often go undiagnosed in underlying conditions, this study will provide physicians about the knowledge of Ponticulus posticus that maybe helpful for establishing an appropriate diagnosis while managing chronic headache.

Prevalence

This study was done in 116 patients using CBCT analysis to assess the prevalence of PP. Prevalence of PP was evaluated with factors like age, gender, partial or complete calcification. CBCT examination revealed 15 patients positive for PP giving a result of **12.9%** as prevalence of PP. The closest results with my study regarding incidence were obtained by Pyo and Lowman, who found an incidence of 12.67% and A.M Calin et al found the incidence of PP was 12.55%. Ibrahim Sevki Bayrakdar et al study using CBCT on the presence and types of PP showed 17.4%. J R Geist et al did a study with CBCT to assess the prevalence of PP and it was 26.2%.

Age

The difference in the prevalence of Ponticulus posticus between the age groups is significant **(P = 0.0368)**. Age seems to influence the prevalence of PP. The mean age of the patients with PP was 38.5 ± 15.5 yrs. In the present study the prevalence of PP was more common in the age group of **11 to 20 years (33.3%)** and the next common age group was 21 to 30 years (22.2%).The results showed decrease in the prevalence of PP as age increases. However, there is increase in the prevalence in the age group of 41- 50years. The result of present study coincides with Juan Schilling study which showed the distribution of the Ponticulus posticus a greater concentration of cases in the age group of 11 to 20 years. Paraskevas et al.believed the prevalence of the Ponticulus posticus is related to age.[39]

In this present study the youngest patient with PP was with the age of 16 years and the oldest was 68 years. Therefore it seemed worthwhile to make a frequency distribution study of the incidence of PP. J R Geist et al studied PP in children and adolescents and found the frequency of PP was greater in patients aged 14 years and older. This suggests that PP bridges can form early in childhood but they may form more frequently after puberty. This goes similar to present study which states that prevalence of this variation differed in different age groups and was found to be seen more in younger individuals. PP is often said to represent ossification of portions of the posterior atlanto- occipital membrane. This is discounted by some authors, who note that mineralization of ligaments is generally a late occurrence in life and would not be a plausible explanation for PP occurring in children. It has been proposed that the prevalence of PP is increased in manual labourers and may have some relation to carrying heavy loads in the neck and shoulder. The present study finding of PP in individuals of the second decade would seem to contradict this theories.[40] It is also

unlikely that PP arises as a hypertrophic adaptation or osteophyte formation. Many previous studies have suggested that it may be a product of congenital development, a genetic trait, an ossification due to age or the result of external mechanical factors. My results also suggest that the presence of the PP is a condition not increasing with the increase in age and therefore should not be considered a calcification or an ossification of the lateral segment of the posterior atlanto occipital ligament.[41] The atlas normally develops from the three primary ossification centres. In only 2% of the population a fourth centre appears which results in the posterior tubercle of the atlas and unites with the lateral masses of atlas. Thus, the development of ossification centres in the atlanto-occipital membrane appears to be spontaneous, and may have a genetic basis because of the reported familial occurrence.

PP is not a rare finding in adolescence and seems to become more common after the age of 10 years. PP does not appear to be regressive or degenerative in nature, and there does not appear to be a need for extra loads on the atlanto occipital junction to produce ponticuli. It may be a congenital or genetic condition or an anatomic variation that arises and mineralizes at various times in early life. Sometimes there may be two separate peaks instead of one in the age incidence (11 to 20 years, 41-50 years).[28] Bimodality indicates that two distinct sets of causal factors might be operative, even though the clinical and pathological manifestations of the disease are the same at all ages. In present study even though there is increase in the prevalence in the age group of 41- 50 years about 19% the prevalence in sixth decade 6.7% and Above 60 years had a minimal prevalence of 4.5%. PP was originally thought to occur as a result of ossification of the atlanto-occipital membrane. However, such a ligamentous ossification tends to be a senile process, and PP does not seem to have a predilection for older age groups. This proves that higher age is not a criteria for the formation of Ponticulus.

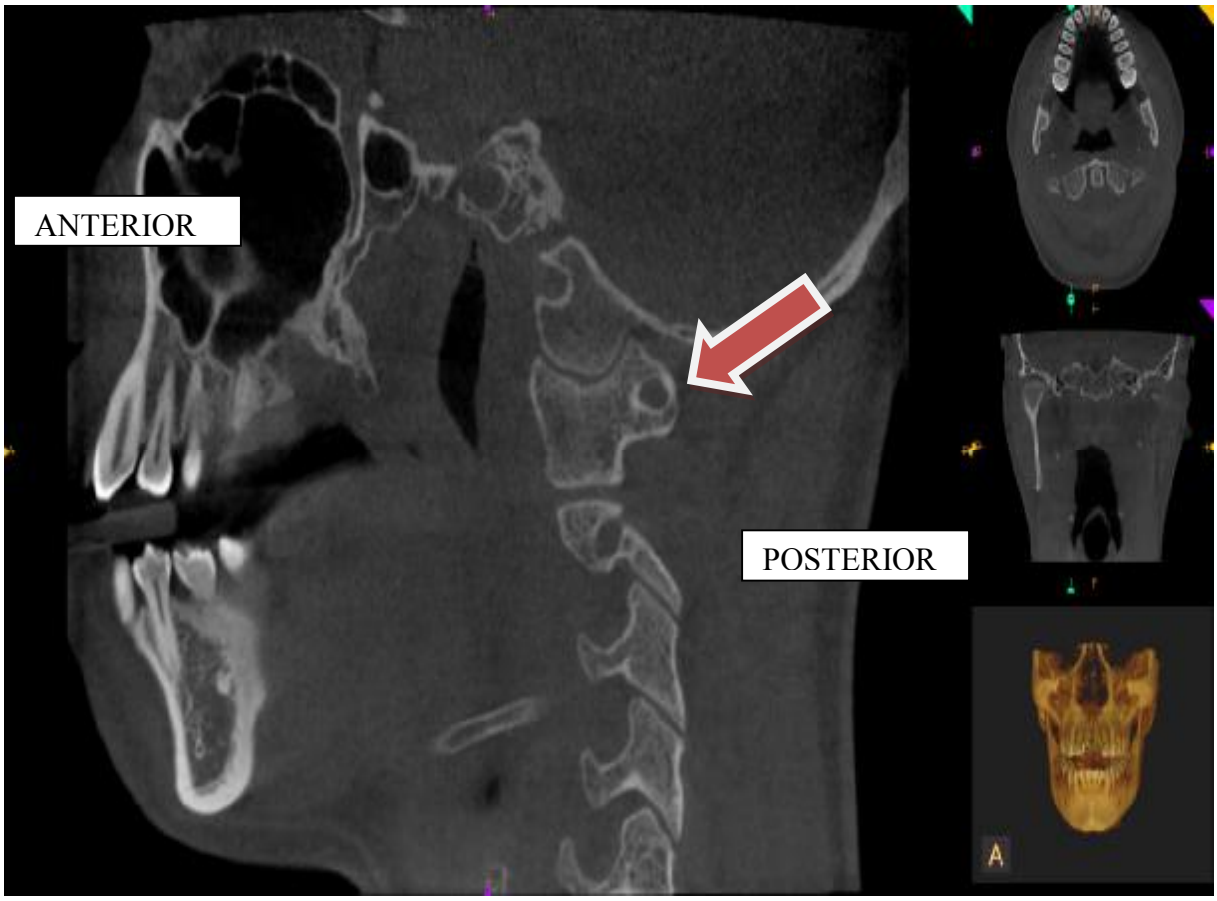


Fig 5. Shows Ponticulus posticus on sagittal slice with one side complete

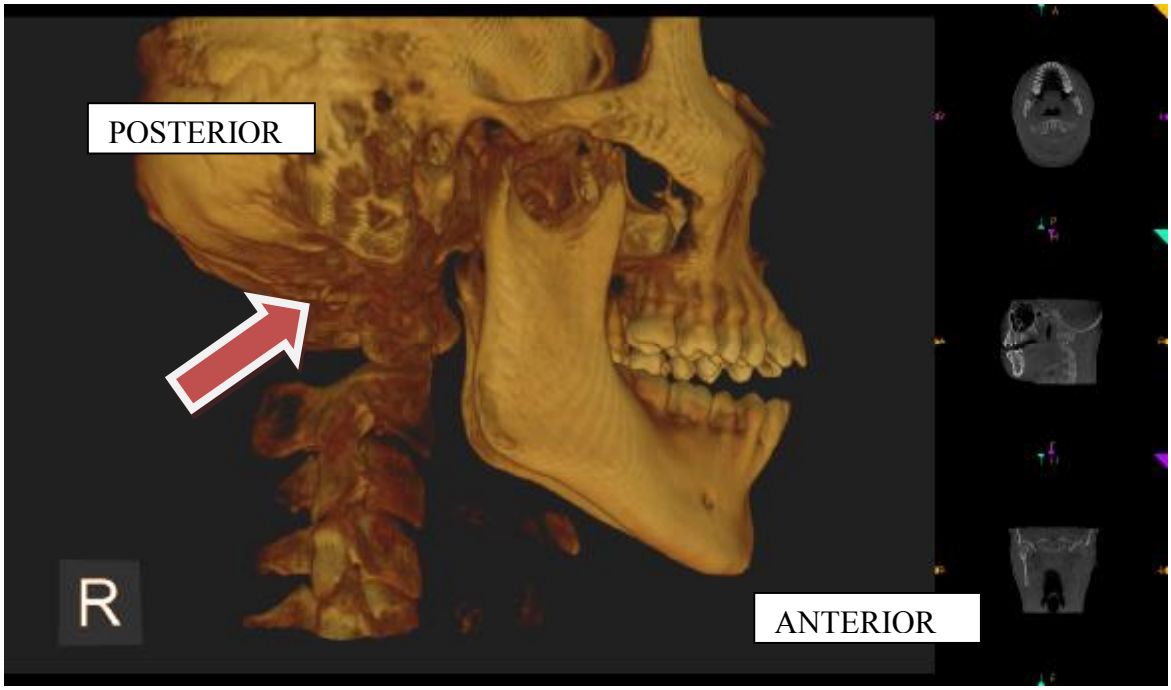


Fig 6. 3D image showing complete Ponticulus posticus on Right Side

Types of PP

In this study, two types of bony rings i.e. partial form and complete form of Ponticulus posticus was found. Out of 15(12.9%), 7(6.02%) had complete type PP and 8 (6.88%) patients had partial type PP. The results showed a negligible difference in both variants of PP. Juan Schilling studied the distribution of the Ponticulus posticus with a prevalence of 5.5% for partial ossification of the bridge bone cases and 4.6% for total ossification.

In the present study 2 patients were below 20 years with 1patient each in complete and partial type. There were 4 patients in the third decade in highest percentage (100 %) with complete type of PP. In the fourth decade of life two patients were in the partial group. One patient had partial PP above in the group age of 60.The possibility that the calcification of the bony bridge progresses overtime from an incomplete bony arch to complete ossification has been described by Paraskevas et al., and also he mentioned about the incidence of complete canal for vertebral artery in labourers to the non labourers. In present study there was 1 case of complete ossification and 1 partial ossification found under 20 years of age and patient's occupations were not taken in to consideration. Thus, while ossification is most likely a gradual process, its initiation not likely to be related to the age of the patient and occupation does not influence the formation of PP. This would confirm the findings of lamberty and zivanovic, who observed the PP cartilage in foetuses and children.

Taitz and Nathan found that partial bony bridges predominate in younger age groups (10 to 30 years) and complete bony bridges in the older age groups (30 to 80 years) which differ from this study that complete bony bridges with a greater concentration in the age group of 21-30 years. It is more likely that PP is congenital or genetic in nature a concept that may be

supported by the finding of cartilaginous precursors to bone bridges in young children. It is also possible that PP develops from the dorsal arch of the pro atlas or represents a similar osseous anomaly of the atlas that exhibits varying degrees of mineralization over time.[42]

Gender

In present study the striking difference in gender distribution showing a higher prevalence of PP in female patients (16%) 8 out of 50 patients than men (10.6%) 7 out of 66 with a p value (0.2041) which was not significant. This fact is coincides with other studies in Chen.C.H, et al. a small female predominance 9% in women vs. 5% in men was noted. George S.Kendrick showed prevalence of 14.6 % male and 16.9% female.[43] Two females with unilateral PP were observed over a one to two year of period. During this period a complete radiopaque PP had developed.

It is possible that the higher prevalence of PP in females than males may be related to an **external mechanical factor**, such as the custom of carrying heavy objects on their heads (Taitz and Nathan). It has been shown that **estrogen accelerates ossification** (Weise et al.) and this could offer an addition explanation to the higher prevalence of the bridges in females.[44] Considering that females are not much involved in such activities than males, this could not offer a plausible explanation for the difference.

In present study the higher occurrence of complete foramen in the females (5 out of 8) to that of males (2 out of 7). The present study results coincide with Cakmak O that complete foramen more common in females than males. The association of the presence of partial foramen with gender was not found statistically significant in my study. In contrary Stubbs

DM et al mentions that complete foramen is significantly more common males and the presence of partial foramen is significantly higher in women.

There are 15 subjects who had PP were classified according to the cederberg et al[45]

Class 1 - 87.1% Class 2 - 4.3 % Class 3 - 2.6% Class 4 -5.2%

One patient had a combination of class 2 on the right side and class 4 on the left side accounting up to 0.8 % (heterogeneous). The results my study shows 87.1% in total population no calcifications across the pathway of the vertebral artery which is considered as class 1. Almost half of the total prevalence of PP belongs to class 4(5.2 +0.8= 6.0%). There is a greater number of Class 4 complete bridges compared with Class 2 and 3 partial PP in patients older than 20 years of age. This suggests that partial bridges progress to complete lesions as children age, a finding that has been reported previously in children and adults.

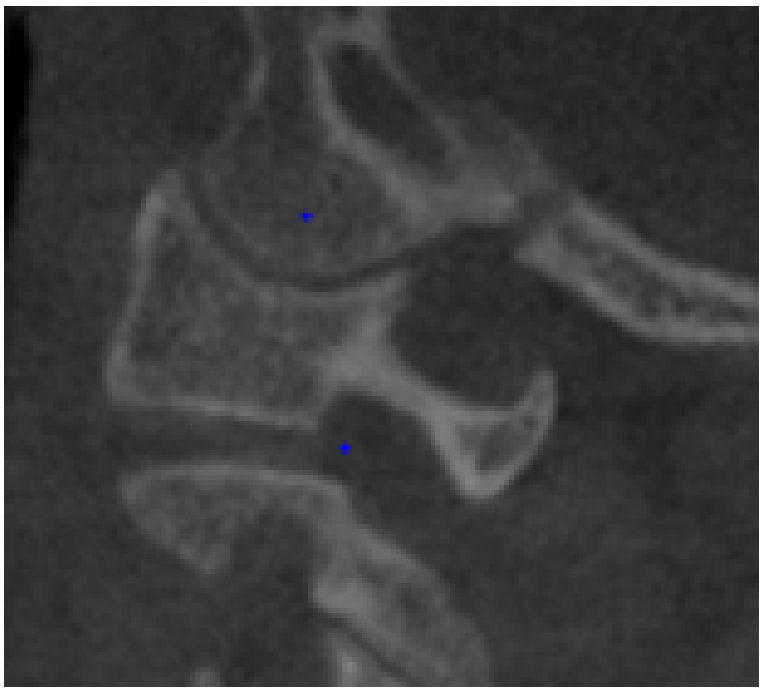


Fig 7.Class-1 PP

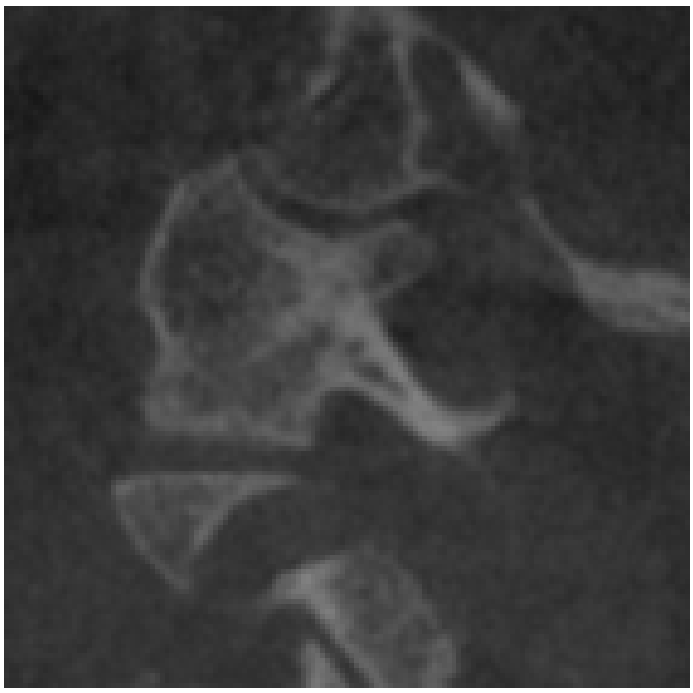


Fig 8. Class-2 PP

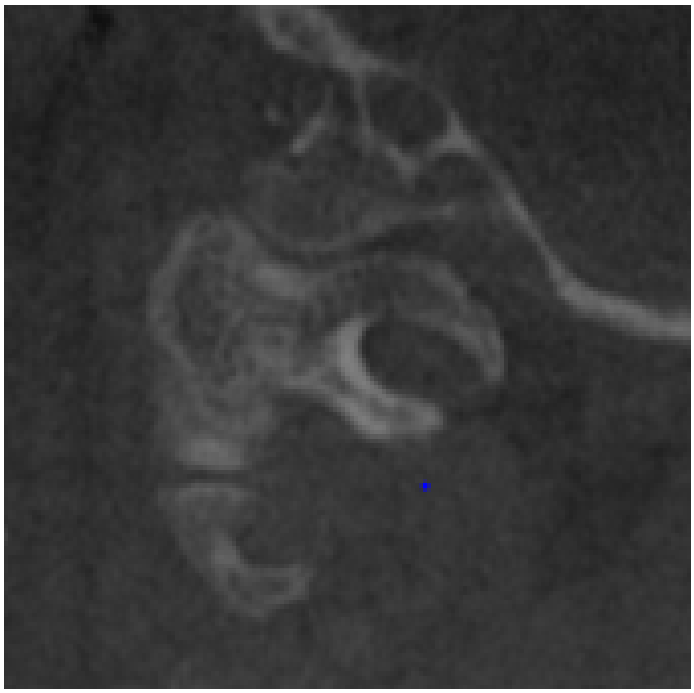


Fig 9. Class-3 PP

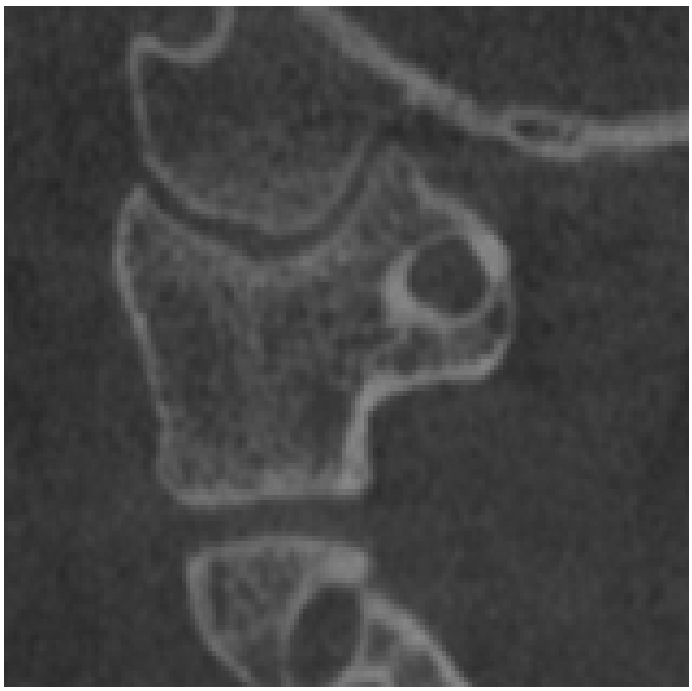


Fig 10. Class-4 PP

Associated Symptoms

In present study 20 patients were symptomatic among them 11 (55%) were associated with presence of PP. The result of present study showed significant relationship between prevalence of PP and association of symptoms**(P = 0.0001).**On screening the asymptomatic patients turned out to be positive for PP and the symptomatic patients too turned out negative for PP. Comparatively more number of positive patients were found in the in the symptomatic group than the asymptomatic group. The symptoms include dull head ache and cervicogenic pain which was aggravated during travel in some patients and some of them were under antidepressants for headaches who were found to be positive for PP on examining based on these symptoms.

In the symptomatic patients 6 (54.5%) patients had complete type of PP and 5 (45.5%) patients had partial type of PP. But 4 patients were positive for PP in the asymptomatic

group. In this 3 patients had partial PP and 1 had complete PP. The symptomatic patients were almost equal in the complete and the partial group while there was increased prevalence of PP among the asymptomatic in the partial group, thus coming to the conclusion that there is no significance in the complete or partial fusion of the PP and its association with the symptoms.

According to the results of present study both partial and complete form of PP can be considered as a possible cause of cervicogenic headache and neck pain. In contrary Parita K.Chitroda et al. indicated that chances of symptoms being present with complete Ponticulus posticus were more than in partial form. Ephrosyni Koutsouraki et al mentioned in their study in which they found symptoms only in patients with partial or incomplete forms of PP.

Limousine suggested that the bridging which encloses the vertebral artery and the sub occipital nerve to form the arcuate foramen may limit the normal mobility of the artery and nerve during the flexion and extension of the neck. He suggested that this might lead to disturbances in arterial flow and periarterial nerve plexus disruption resulting in headaches, retro orbital pain, vasomotor disturbance of the face, disturbances of vision and difficulty in swallowing and speaking.

Association Of PP With Eagle's Syndrome

In present study there were also 3 patients, 2 female and 1 male who exhibited eagle syndrome (elongated styloid process) who were symptomatic. In these 3 patients only 1 patient was positive for PP with bilateral complete ossification on examination.

The elongated styloid process can cause craniofacial and cervical pain, difficulties in swallowing, secondary glossopharyngeal neuralgia, radiating pain into the orbit or maxillary

region (Fini et al., 2000). Other complaints include feeling of foreign body in the throat, tinnitus, otalgia, pain along the distribution of the carotid artery, and headache (Keur et al., 1986; Ghosh and Dubey, 1999). The length of the styloid process has been estimated on the CBCT images.

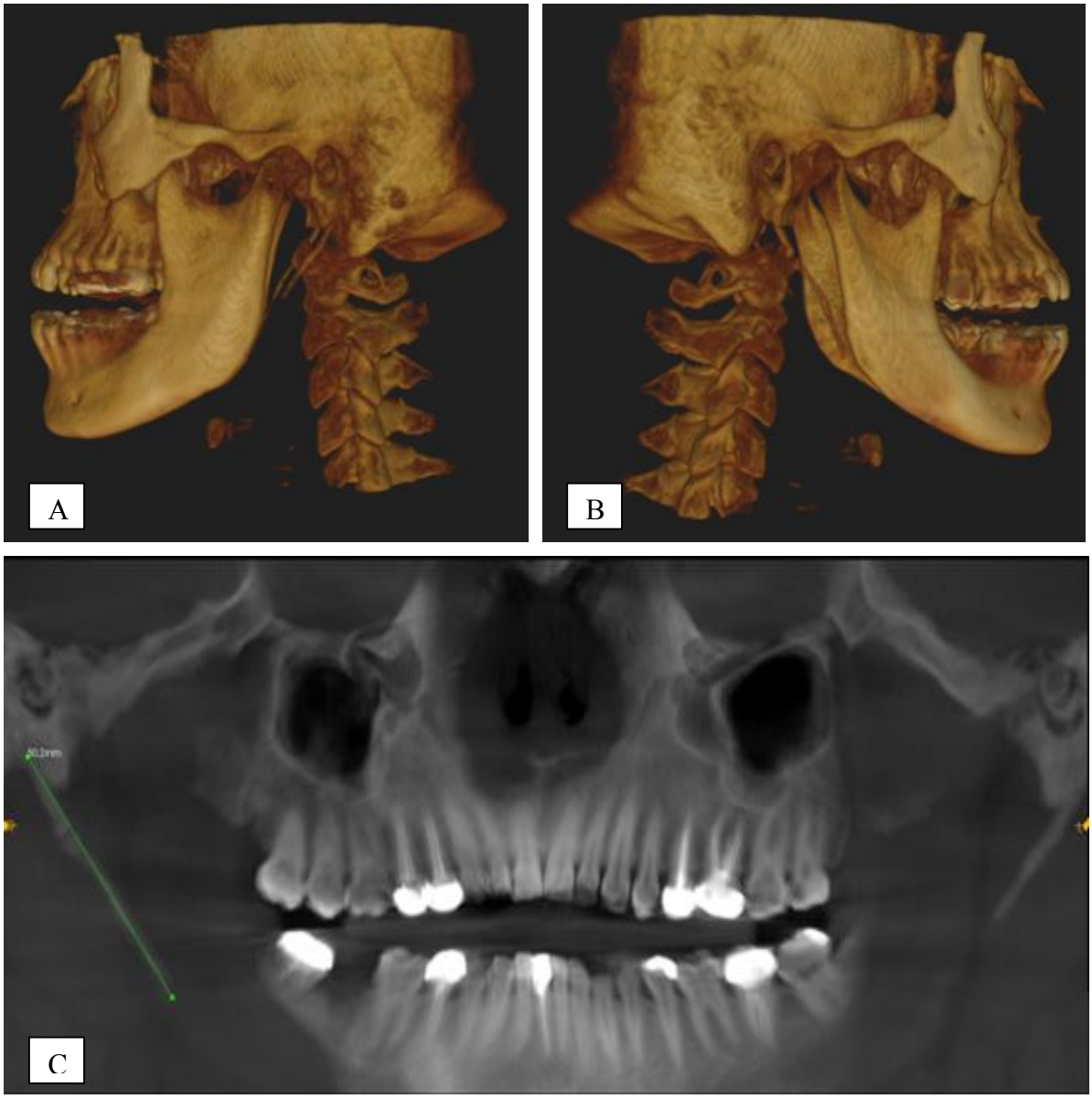


Fig 11. PP with Elongated Styloid Process A.3D Image Left Side View B.3D Image Right Side View C.Length of Styloid Process

The symptoms of Ponticulus posticus (PP) include cervical pain and headache have also been associated with elongated styloid process (ESP) inspection of whether the patient has a ponticulus posticus seems reasonable to ensure that all or some of the symptoms are not arising from a congenital anomaly of the atlas.[46] Few studies investigating the relationship between the two disorders PP and ESP in the literature. A.E. Sekerci et al. study suggests that there is a significant correlation between the presence of PP and ESP. When surgical removal of an ESP is considered, inspection as to whether the patient has a PP seems reasonable to ensure that all or some of the symptoms do not arise from a congenital anomaly of the atlas.

Intensity of pain

Sternbach has shown that "pain" in acute is a symptom of disease, "pain" in chronic is the disease itself. Instantly, it should be obvious that pain management is a complex undertaking. In this study Out of 116 patients a total of 20 patients had pain ranging from mild to moderate intensity. Among those 14 patients experienced mild intensity and 6 patients had moderate intensity of pain. After the screening (6 out of 14) 42.9 % of the patients who were positive for PP exhibited mild pain and (5 out of 6)83.3 % had moderate pain.

Ephrosyni Koutsouraki, in a case report the intensity of pain was moderate to severe and the patient mentioned no accompanying symptoms such as photophobia, vertigo, nausea, or vegetative symptoms. The frequency of these episodes was between two and four per month. This anatomical variation can be the cause of cervicogenic headache and migraine.[47] The mechanism of induction of these symptoms is potentially analogous to that mentioned above, that is the transient ischemic compression of the vertebral artery during its passage through

the arcuate foramen and/or increased tension on the duramater in the area of cervico-occipital junction.

Lamberty and Zivanovic have shown that PP is closely attached to the atlanto occipital membrane and it is known that this membrane is connected to the Dura. Especially when the head is moving, the neurodynamic process may lead to these conditions because of traction on the Dura and this can result in pain.[48]

Laterality

In present study Out of the 15 patients 8 patients (53.3%) had unilateral PP and 7 patients (46.7%) had bilateral prevalence of PP. There is almost no significant difference in the laterality. In the unilateral patients who were 8 in number 4 patients exhibited PP in the left side and the remaining 4 patients exhibited PP in the right side amounting to 26.6% equal distribution of PP on both right and left side. This coincides with Young et al; PP was almost equally detected in both the left and right sides. In contrary study by lamberty and zivanovic showed bilateral type having the lowest incidence and in the unilateral the left only the highest incidence. Dhall et al attributed the higher incidence on the left side to the right handedness of the individual since the strong sternocleidomastoid muscle bends the head to the opposite side.[49] Owing to the right-sided dominance of muscles of the body in right-handers, the larger and consequently stronger right sternocleidomastoid would tend to tilt the head to the opposite side (Pande & Singh 1971). According to Paraskevas et al. (2005), the side predilection of the retro articular canal has no anatomical explanation.

Superior articular facet

Superior articular facet is present on the upper surface of atlas lateral mass, and forms an atlanto occipital joint with occipital condyle which provides the vertical loading for the weight of the head, and is responsible for nodding movement.[50] The detailed three dimensional images of dentomaxillofacial structures derived from CBCT may allow more accurate determination of the demographic features, morphology pattern, and SAF measurement.

To investigate the differences of the atlas SAFs on the PP and non PP sides, the mean values of the anteroposterior dimension long axis, the transverse dimension long axis, and the elliptical area were, respectively, compared in the unilateral complete PP (n =4) and the unilateral partial PP (n=4) groups.

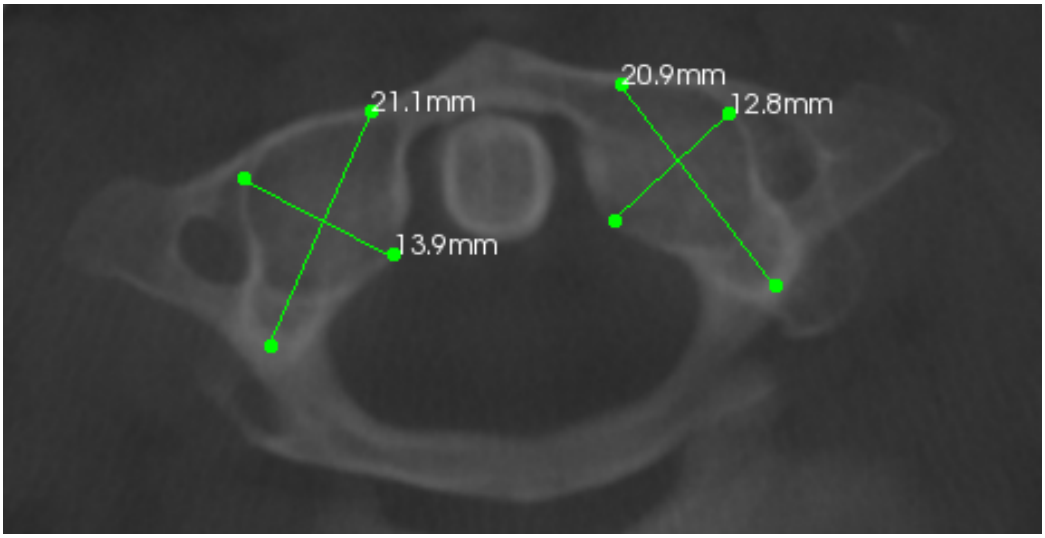


Fig 12-Measurement of Superior Articular Facet

In present study data showed increase in the mean anteroposterior dimension, transverse dimension, and area on the PP side compared with those on the non PP side both complete and partial types. The present study results show the area of the superior articular facet in the PP side was found to be higher.

Previous studies have reported left and right asymmetry of superior articular facet that can be hypothesized by the unequal weight bearing and asymmetry use of the cervical spine as a result of more common left tilted head posture in a right with the stronger right sternocleido mastoid muscle. Dhall et al have observed the larger SAF on the side of PP. Alteration in the morphometry of SAF will alter ergonomic of the atlanto occipital joint.[51]

Association with gorlin goltz syndrome is negative in this study. Atlanto occipital ligament calcification has the advantage of being easily detectable on CBCT, thus it could represent an extremely important aid in the early diagnosis of NBCSS, when in the absence of major features such as Basal Cell Carcinoma, jaw cyst or falx cerebri calcification, which are often not evident until much later, other radiological manifestations.

Most of the authors described that the ossification of free margin of atlanto occipital membrane, is a late process, which occurs with increasing age and many authors have stated that ponticle formation is a regressive and disappearing morphological phenomenon. In this study the incidence of Ponticulus posticus is not related with gender but age appear to be related to the frequency of occurrence of complete foramina. The results of present study suggest that the presence of PP is a condition independent of age, and therefore should not be considered a calcification or an ossification of the lateral segment of the posterior atlanto

occipital ligament, but rather an ossification with functional significance developed in other primates (Krishnamurthy et al 2007).

The potential clinical significance of Ponticulus posticus is controversial because the majority of patients with this finding are asymptomatic. However, symptoms that maybe associated with ponticulus posticus include migraine, vertigo, diplopia, and neck pain. PP is generally regarded as a simple anatomical variant. However, the compression of the nervous and vascular structures passing through the foramen (vertebral artery, periarterial plexus, and sub occipital nerve) may result in a combination of symptoms such as cervical migraine, neurosensory-type hearing loss, neck pain, vertigo, shoulder arm pain, and, in some instances, even loss of postural muscle tone, consciousness, and vertebrobasilar insufficiency syndrome. Headache, neck, and shoulder arm pain as well as vertigo have been found with significantly greater frequency in various studies reported. However in the present study the commonest associated symptoms were headache and neck pain. Thus the clinical importance of PP lies in recognition as well as potential therapeutic intervention.

CONCLUSION

CONCLUSION

Since past few years, a greater awareness has developed of how minor anomalies of the atlanto-occipital region may result in pathophysiologic conditions of clinical significance.

Migraine is known to have a multifactorial origin, with both extrinsic and intrinsic trigger mechanisms that increase its frequency. Numerous studies suggest an increased incidence of PP in patients with common migraine and, as such, may be considered to be an associated, if not a causal, factor.

Ponticulus posticus is a relatively common finding which should be mentioned by radiologists in their reports, the awareness of the presence of this variant can improve later management of head and neck symptoms. CBCT is an important tool for diagnosis and characterisation of PP in three dimensional views, providing professionals with access to excellent image quality and greater diagnostic accessory and sensitivity. This study suggests the prevalence of PP is higher than previously believed and PP is a common anomaly. It should be considered as one of the factor when symptoms of headache, cervicogenic pain, migraine are present and in asymptomatic individuals the possible role and future consequences of PP can be predicted.

Dentists examining CBCT scans should look carefully for PP because these abnormalities may be related to otherwise unexplainable head and neck pain and others symptoms related to compression of the vertebral artery and sub occipital nerve. In this day to day world human beings are succumbed to many chronic illnesses of varied etiology. We, the dentomaxillo-facial radiologists and oral physicians should be concerned about this. Although the dentomaxillofacial radiologists is not directly concerned with the management of cervical spine anomalies, we do have an obligation, as a healthcare professional, to take any such findings that may hold importance for the patient to their logical conclusion.

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ANNEXURE

BEST DENTAL SCIENCE COLLEGE

ULTRA TRUST

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ANNEXURE I

Ref:UT:BDSC:IRB-EC/2014

Date:18.11.2014

From

Institutional Review Board-Ethical committee,
Best dental science college,
Madurai .

To

The Controller of Examinations ,
The Tamil Nadu DR.MGR Medical University,
No. 69, Anna salai,
Guindy,
Chennai-600 032

Sir/Madam

The Dissertation topic titled " PREVALENCE OF PONTICULUS POSTICUS IN DENTAL PATIENTS USING CBCT- A RADIOLOGIC STUDY" submitted by DR.G.SATHEES CHANDRA MOULI postgraduate student has been approved by Institutional Review Board of Best Dental Science College on 18.11.2014.

DR.K.S PREM KUMAR.M.D.S.,
VICE PRINCIPAL
MEMBER SECRETARY
INSTITUITONAL REVIEW BOARD-ETHICAL COMMITTEE
BEST DENTAL SCIENCE COLLEGE
MADURAI

DR.PURUSHOTHAM MANVI.,M.D.S.,
PRINCIPAL
BEST DENTAL SCIENCE COLLEGE
MADURAI

PRINCIPAL
BEST DENTAL SCIENCE COLLEGE
MADURAI-625104

INFORMED CONSENT

I confirm that I have read the participant information sheet on ____/____/____ or it has been read to me, that I understand it, that I have had the opportunity to ask questions about it, and that my questions have been answered to my satisfaction.

I have no objection to being a part of this study. The operator has promised to keep the confidentiality of my personal records. I understand that my participation is voluntary and I am free to withdraw at any time.

(In case of illiterate participant the information is explained and thumb impression is obtained in the presence of an unrelated witness. Left hand thumb impression for female and right hand thumb impression for male)

(In case of minor patients the procedure is explained to the minor and informed consent is obtained from the parents or guardian)

Name of the Participant: _____

Signature or thumb impression: _____

Date: _____

Name of Researcher:

Signature: _____

Signature of Guide:

Signature of HOD:

INFORMED CONSENT

Participant information sheet

Topic of Research

Prevalence of ponticulus posticus in dental patients using CBCT – a radiologic study

Introduction of the proposed research

Cervicogenic pain due to ponticulus posticus needs to be identified since the success of treatment. You will be asked about the history, intensity of pain and associated symptoms. However, before you give your consent to take part in this study, you must read and understand the explanation of the proposed study. It describes the purpose and the benefits of the study. After you have read it please feel free to ask any questions you may have .This to make sure you understand what your participation in this study may involve before you sign and date the consent form. The results of your samples will be kept confidential and used for the research only.

அறிவிக்கப்பட்ட ஆய்வின் படிவம்

இந்த ஆய்வில் பங்கேற்போர் தகவலில் உள்ள செய்தியை படித்திருக்கிறேன் என்று உறுதி கூறுகிறேன் அல்லது இத்தகவல் எனக்கு படித்துக்கான்பிக்கப்பட்டது. அதை நான் புரிந்து கொண்டேன்.மேலும் நான் அந்த தகவலைப்பற்றி எந்த சந்தேகம் இருந்தாலும் அதைக் கேட்க்கும் வாய்ப்பு தரப்பட்டது.

நான் இந்த ஆய்வில் பங்கேற்பதற்கு முழு சம்மதம் தெரிவிக்கிறேன். என்னைப்பற்றிய தகவலை ரகசியமாக வைத்திருப்பேன் என்று ஆய்வில் கூறப்பட்டுள்ளது. நான் இந்த ஆய்வில் முழு சுதந்திரத்துடன் பங்கேற்கிறேன்.

(கற்றறிவில்லாதவர்களுக்கு இந்த தகவல் படித்துக் காண்பிக்கப்பட்டது. கையொப்பமிடத் தெரியாதவர்களுக்கு ஆண்களில் வலது கை பெருவிரல் ரேகையும் பெண்களில் இடது கை பெருவிரல் ரேகையும் பெறப்பட்டது).

18 வயது பூர்த்தி செய்யாதவர்களுக்கு அவர்களின் பெற்றேரிடமிருந்து ஒப்புதல் பெறப்படுகிறது.

ஆய்வில் பங்கேற்பவரின் பெயர் :

கையொப்பம் அல்லது பெருவிரல் ரேகை :

தேதி :

ஆய்வு மேற்கொள்பவரின் பெயர் :

கையொப்பம் :

வழிகாட்டுபவரின் கையொப்பம் :

பேராசிரியரின் கையொப்பம் :

INFORMED CONSENT

I confirm that I have read the participant information sheet on 11/06/2015 **or it has been read to me, that I understand it, that I have had the opportunity to ask questions about it, and that my questions have been answered to my satisfaction.**

I have no objection to being a part of this study. The operator has promised to keep the confidentiality of my personal records. I understand that my participation is voluntary and I am free to withdraw at any time.

(In case of illiterate participant the information is explained and thumb impression is obtained in the presence of an unrelated witness. Left hand thumb impression for female and right hand thumb impression for male)

(In case of minor patients the procedure is explained to the minor and informed consent is obtained from the parents or guardian)

Name of the Participant: JASMINE

Signature or thumb impression: Jasmin

Date: 11/6/2015

Name of Researcher: A. SAJEETH CHANDRAMOULI

Signature:

CASE HISTORY

PATIENT DEMOGRAPHIC DATA

NAME: **OP NO:**

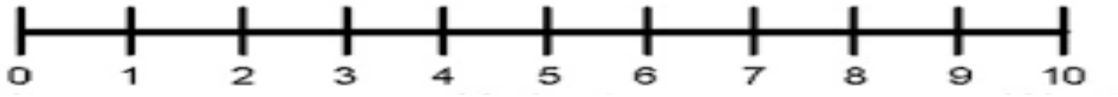
AGE:

SEX: **ADDRESS:**

CHIEF COMPLAINT:

HISTORY OF PRESENT ILLNESS:

VISUAL ANALOG SCALE



MEDICAL HISTORY:

DENTAL HISTORY:

FAMILY HISTORY:

PERSONAL HISTORY:

GENERAL EXAMINATION

VITAL SIGNS

BLOOD PRESSURE:

PULSE RATE:

TEMPERATURE :

RESPIRATORY RATE:

INTRA ORAL EXAMINATION

HARD TISSUE:

SOFT TISSUE:

PROVISIONAL DIAGNOSIS:

INVESTIGATIONS:

PATIENT WAS SUBJECTED TO CBCT.

CBCT INTERPRETATION / PRESENCE OF PONTICULUS POSTICUS:

LATERALITY		CEDERBERG CLASSIFICATION	
Unilateral		**Class 1**	
Bilateral		**Class 2**	
Right /Left		**Class 3**	
		Class 4	

S.NO	NAME	AGE	SEX	NATURE OF PAIN	INTENSITY	INTRA ORAL EXAMINATION	PROVISIONAL DIAGNOSIS	INVESTIGATION	GEORGEBERG CLASSIFICATION OF IMPACTED MOLARS	LATERALITY	SIDE	FINAL DIAGNOSIS
1	Anitha.C	61	F			Completely Edentulous	Completely edentulous	CBCT Done	Class-1	-	-	-
2	Arulmigupathi.M	47	F			Missing Teeth 31,32,33,34,35,36,37, 41,46	Partially edentulous Lower arch	CBCT Done	Class-4	Unilateral	Left	Pericoronitis Posticus
3	Ayyakkannu.A	51	M		Mild	Missing Teeth 13-17, 21-23, 25-27	Partially edentulous, Dentocarie	CBCT Done	Class-1	-	-	-
4	Balakrishnasamy	53	M	Nagging		Dental Caries-46 Impacted-48	Impacted 48	CBCT Done	Class'	-	-	-
5	Balachandran	66	M			Completely Edentulous	Completely edentulous	CBCT Done	Class-1	-	-	-
6	Balaraj	51	M			Missing Teeth 15, 16, 26, 36, 45, 46	Partially edentulous Upper and lower arch	CBCT Done	Class 1		-	-
7	Banumathi	55	F			Completely Edentulous	Completely edentulous	CBCT Done	Class-3	Unilateral	Left	Pericoronitis Posticus

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